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Simulating Changes in Even-Aged Timber Stands

by
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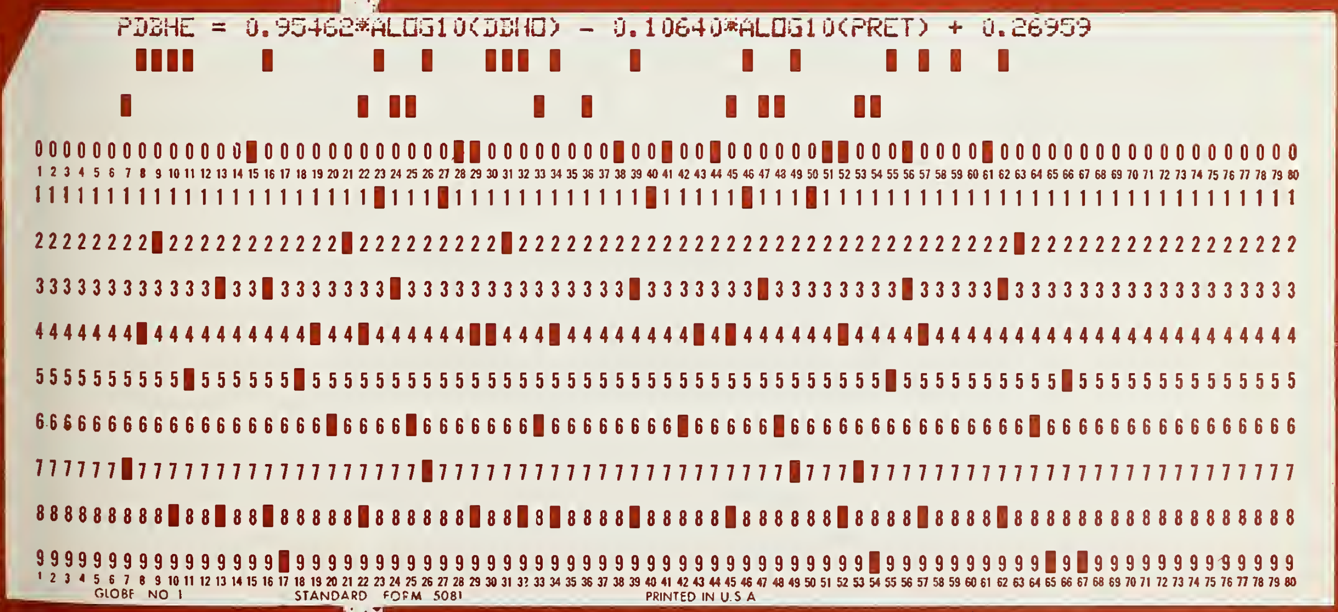
Forest Service



Abstract

Growth and volume relationships are assembled in a computer program, written in FORTRAN IV, that simulates timber management by shelterwood, seed tree, or clearcutting systems. Tree growth, intermediate and regeneration cuts, planting, and catastrophic losses are among the changes computed. Annual and periodic costs and returns, analysis of rate earned, and other statements of volume and value are printed. Supersedes USDA For. Serv. Res. Pap. RM-42.

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Contents

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Clifford A. Myers

Computer program MANAGD (Myers 1968) was developed so that managers could simulate operations in managed, even-aged timber stands. The original relationships and analytic procedures have now been modified and improved to the point where computer program MANGD2, described in this new Paper, has been written to supersede the original program MANAGD. Major modifications permit more general treatment of regeneration cuttings and more accurate estimates of the effects of intermediate cuttings on stand characteristics. Other changes are the result of increases in available data and experience gained in use of program MANAGD. Program organization now provides a means for accommodating a large number of species with a single copy of the source program.

MANGD2 is written in standard FORTRAN IV and can be run on almost any computer that provides at least 28,544 (67,600 octal) memory locations.

Persons wishing to prepare data decks and use the program should read the entire Paper carefully. Those who are interested only in knowing what MANGD2 can do for them can concentrate on the sections headed "Uses of Simulation" and "An Application of MANGD2."

Uses of Simulation

Several characteristics of the business of timber production make the gathering of information on which to base management decisions for forest lands unusually difficult. Among these problem characteristics are:

1. The long time needed to mature a crop. Final results of a series of changes may not be evident for many years, especially with slower growing species.
2. The slowness with which the results of a single change may appear. Today's questions may not be answered for many years. Conversely, the desire for on-the-ground experimentation will be restrained because results of unfavorable treatments will not disappear for some time.
3. The large land areas and the numerous possible combinations of biological and economic conditions for which decisions must be made. Many possible combinations result in many possible options, among which there may be one or several that will conform to the capabilities and goals of the organization.
4. The expense of imposing treatments on forest stands. Expense limits the number of options that can be examined on the ground and increases the value of information.

A managerial tool designed for managers faced with such problems is available. It is the technique of mathematical simulation on a digital computer. Simulation is particularly useful where an outcome depends on many variables and parameters, and the computation steps are numerous (Cremeans 1967).

Simulation involves the creation and operation of a model that resembles logically the system studied (Martin 1968). Solving a problem by following the changes that occur during model operation constitutes the technique of simulation (Gordon 1969). The system may be a sawmill, a working circle, or other item of interest. Only as much of the system is modeled as is necessary to answer the questions that prompt the study. Mathematical models, such as MANGD2, represent all necessary components and interactions of the system by a series of mathematical relationships. Properly used, they can aid in the discovery of new facts and the test of alternatives.

Simulation answers questions of the type: "What would happen if I did this . . .?" Once a forest system has been modeled and the model found to be acceptable, a manager has great flexibility in imposing changes on his forest model. He can vary his management goals and the conditions of his stands with no ill effects to the real stands from any undesirable alternatives. With adequate mathematical relationships, the manager can predict probable future performance and yield of his forest (Chorafas 1965). In seconds, he can get an estimate of the long-term effects of proposed changes on growth, yield, and money return. The changes can involve rotation length, cutting cycle, frequency and intensity of thinning, and other controls. Estimates of potential advantages from reductions in certain costs or from increases in selling prices can be obtained.

MANGD2 was designed to be one of a set of tools useful as aids in decisionmaking. The tools and a possible pattern of their use are:

1. The manager can compute yield tables for managed stands to help him establish controls on his operations. For example, he can determine that certain combinations of frequency and intensity of thinning are not acceptable alternatives because more than one noncommercial thinning would be needed. Perhaps stands of low site quality should not receive any treatment other than protection. Yield tables will help decide what the limit should be. Procedures for computing yield tables are described elsewhere (Myers 1971).
2. Since goals will not be set on the basis of growth and yield in volumetric units alone, the manager will, therefore, use MANGD2, described in this Paper, to obtain additional information. Only through simulation can the long-term effects of changes in rotation length, cutting cycle, and other controls be determined. Likewise, simulation is needed to express the results in terms of present worth and rate earned. MANGD2 will usually be used to answer questions of the type: "What do I want my working circle to be when it has been converted to managed stands?"
3. Once the controls have been established (subject, of course, to future reappraisal), the manager needs a guide to assist him in current operations. The guide should contain such items as allowable cut, present and desired distribution of acres by age and site quality classes, and work to be completed during the current planning period. The guide should be computed at least annually, using data from conventional inventory and other sources of stand description. Procedures for preparing such a guide are described elsewhere (Myers 1970).
4. Once the controls have been established and a management guide is available, the manager is concerned with converting his forest to match his goals. A simulation program that uses actual inventory data as stand inputs will be useful. Simulation with MANGD2 helps set the goals; a second simulation program, not restricted to growth of managed stands, can show him how to attain them.
5. An important step in decisionmaking may be necessary after each of the previous steps. This is the return to earlier steps in the decision process whenever new information indicates a need for such action.

Description of Program MANGD2

Program MANGD2 is a tool for simulating the management of even-aged timber stands for wood products. It contains provisions for stand growth, thinnings, regeneration cuts, planting of nonstocked areas, and other changes in forest conditions. Inputs to the program permit wide choice in the management alternatives and stand conditions to be examined. Possible options and alternatives are described in the appropriate parts of this section. Program organization permits ready modifications to fit local tree species or utilization standards.

MANGD2 consists of a main program and 21 subroutine subprograms (appendix 1). Content and purpose of each routine are given in the sections that follow. Variable names are defined with the source program in appendix 1 and in the listing of contents of the data deck. The test problem described on page 16 and reported in appendix 2 provides additional explanation of the program.

The terms batch, test, and game are used to identify individual simulation jobs performed with various groupings of alternatives. The BATCH name identifies one entire group of tests and games to be completed as a single job by a computer. A test consists of one or more games, all of which are based on a single yield table and one set of stumpage prices. Games of a test may differ from one another in one or more of the following: (1) distribution of acres by age classes, (2) total area, (3) area planted annually, (4) area lost annually, (5) costs of operations, and (6) limitations on the annual cut.

As shown in the program listing (appendix 1), a single program deck can be used for several tree species. One program at a central location can thus serve the needs of many managers. Each part of a subroutine that involves species-specific relationships begins with a computed GO TO statement. Each GO TO is followed by as many FORTRAN statements for species-specific relationships as desired. The label of each statement appears in the computed GO TO. The GO TO counter is read in initially as a numerical species index, together with the species name as it will appear in table headings.

In appendix 1, the program provides for three species. In each set of species-specific relationships, the first equation applies to ponderosa pine (*Pinus ponderosa* Laws.) in the Black Hills of South Dakota and Wyoming. The second equation applies to lodgepole pine (*Pinus contorta* Dougl.) in Colorado and Wyoming. Space for an equation applicable to

a third species is occupied by a dummy statement in the form of a CONTINUE statement. The relationships included can be replaced by those for other species, or each computed GO TO can be expanded to provide for additional species.

Main Program

The main program calls 15 subroutines in proper sequence, and uses counter IJK to call a sixteenth (REPRT1) at specified intervals. The first two subroutines called (BASIS1, CHEK1) read and check that part of the data deck common to all games of one test. The next two subroutines (YIELD, ANVOL) compute and print a yield table and potential volumes per acre at each year of stand age.

Of the remaining 12 subroutines, one may be called at the end of each test, six are called once each game, four are called each year of each game, and REPRT1 is called as needed. Four routines (BASIS2, CHEK2, START, AREAS) read and check the data deck for a game, generate a working circle with the specified number of acres in each age class, and print conditions at the start of the game. Four routines (COVER, HRVST, SUMS, ANUAL) create the desired annual changes. Annual operations include stand growth, thinnings, regeneration cuts, losses, and other changes in volume and value. Dollar values useful in determination of the rate earned are printed at the end of each game (WORTH), as is a complete summary of volumes and values (REPRT2). An optional subroutine (SUMRY) prints selected values from all games of a test, one set per page, to simplify comparisons.

The main program enters BATCH name and the number of tests in one run or job into computer memory. Loops that control the number of tests, the number of games in a test, and the number of years in a game are in the main program.

Subroutine BASIS1

BASIS1 is called once each test to read values that apply to all games of the test. Values entered include stumpage prices, minimum commercial volumes, and items used to compute a yield table. Stand age at regeneration cut, frequency of cut, and density of any residual stand are entered to select and control the silvicultural system used for regeneration. Controls on the program are entered as number of games in the test. number of years in each game, and the columns of REPRT2 to be printed by SUMRY. Variables that pertain to an entire test are initialized by BASIS1.

Definitions of the variables, restrictions on their values, and other necessary information are presented in the section headed Data Deck.

Subroutine CHEK1

CHEK1 edits the data cards read by BASIS1 to insure that certain errors do not occur. Terminal indexes of DO loops and counters of computed GO TO are checked to be sure they are not smaller than one or larger than the dimensions specified for related variables. Variables used in growth and other equations are checked to be sure they do not have zero or negative values. Additional statements can be added to further edit the data cards, such as specifying maximum values for various variables.

Identification of an error by CHEK1 prevents continuation of the job. The two error flags are examined when control is returned from CHEK1 to the main program. A nonzero value of either flag will cause the printing of an error message and termination of the job.

Subroutine YIELD

YIELD computes and prints yield tables for managed, even-aged stands. It is called once each test to produce the yield table that will apply to all games of the test. Values in each yield table reflect prior decisions on the frequency and intensity of intermediate cuttings and the nature of reproduction cuttings. Data related to these decisions are read in by BASIS1.

Computations performed by the subroutine follow procedures described in detail elsewhere (Myers 1971). Average stand diameter (d.b.h.) and number of trees per acre just before initial thinning are used as read in by BASIS1. Reasonableness of the values will have been checked previously by comparison with measurements of actual stands of suitable ages, densities, and site qualities. Basal area and the average height of dominant and codominant trees are computed. YIELD then calls subroutine VOLS to compute volumes per acre before thinning. Subroutine CUTS is called to compute d.b.h. after cutting to the residual level defined in equations based on values in table 1 and by THIN from BASIS1. The stand will not be thinned if its density is already at or below the appropriate residual. Postthinning basal area and average height are computed and subroutine

Table 1.--Basal areas after intermediate cutting in relation to average stand diameter. Growing stock level 80.

Average stand d.b.h. after cutting (Inches)	Basal area per acre	Average stand d.b.h. after cutting (Inches)	Basal area per acre	Average stand d.b.h. after cutting (Inches)	Basal area per acre	Average stand d.b.h. after cutting (Inches)	Basal area per acre
	Sq. ft.		Sq. ft.		Sq. ft.		Sq. ft.
2.0	12.1	4.0	35.2	6.0	56.6	8.0	72.5
2.1	13.2	4.1	36.4	6.1	57.6	8.1	73.1
2.2	14.4	4.2	37.6	6.2	58.5	8.2	73.7
2.3	15.5	4.3	38.7	6.3	59.4	8.3	74.3
2.4	16.7	4.4	39.9	6.4	60.3	8.4	74.8
2.5	17.9	4.5	41.0	6.5	61.2	8.5	75.3
2.6	19.0	4.6	42.2	6.6	62.1	8.6	75.8
2.7	20.2	4.7	43.4	6.7	62.9	8.7	76.3
2.8	21.3	4.8	44.5	6.8	63.8	8.8	76.7
2.9	22.5	4.9	45.7	6.9	64.6	8.9	77.1
3.0	23.7	5.0	46.8	7.0	65.4	9.0	77.5
3.1	24.8	5.1	47.8	7.1	66.2	9.1	77.9
3.2	26.0	5.2	48.8	7.2	67.0	9.2	78.2
3.3	27.1	5.3	49.8	7.3	67.7	9.3	78.5
3.4	28.3	5.4	50.8	7.4	68.5	9.4	78.8
3.5	29.5	5.5	51.8	7.5	69.2	9.5	79.1
3.6	30.6	5.6	52.8	7.6	69.9	9.6	79.3
3.7	31.8	5.7	53.8	7.7	70.6	9.7	79.5
3.8	32.9	5.8	54.7	7.8	71.2	9.8	79.7
3.9	34.1	5.9	55.7	7.9	71.9	9.9	79.8
						10.0+	80.0

VOLS is called again to compute volumes per acre. D.b.h. is then increased by the amount of periodic growth, and the number of trees is reduced, if necessary. CUTS is called again to perform the second thinning, this time to level DLEV read in by BASIS1. The sequence of steps is repeated as many times as necessary until terminated by the final cut at the age appropriate to the regeneration system used. Stand age and other state variables are printed at the end of each series of operations.

Table 1 gives residual basal area after intermediate cutting for various average stand diameters. The values represent one possible series of densities that could be used to guide successive thinnings in a stand. Basal area increases with diameter until 10.0 inches diameter is reached, and remains constant thereafter. The series in table 1 is labeled "growing stock level 80" to indicate that reserve basal area is 80.0 square feet per acre when d.b. h. after cutting is 10.0 inches or larger. Other stocking levels are named the same way. For example, stocking level 100 means that reserve basal area will be 100 square feet when d.b.h. after cutting is 10.0 inches or larger. Basal areas for level 100 and for diameters smaller than 10.0 inches are obtained by multiplying each basal area of level 80 by the amount 100/80. Values for other stocking levels, perhaps from 50 to 160, are computed similarly. The ratio is computed frequently in MANGD2 as THIN/GIDE or DLEV/GIDE.

Data used to obtain the base curve, level 80 in table 1, came from permanent and temporary plots. A graph of desired basal area over average stand d.b.h. was drawn for plots of local average site quality. "Best" stand density for each average diameter sampled was based on such criteria as production in cubic feet and probable length of saw-log rotations.

Increases in d.b.h. due to tree growth, percentages of mortality, and other periodic changes in stand conditions are for a specific length of projection period. The length, in number of years, is entered as RINT by BASIS1. Equations in the listing of YIELD in appendix 1 are for a projection period of 10 years. Intervals between intermediate cuttings are one or more projection periods long.

The yield table will show numbers of trees and other values appropriate to the regeneration system selected. Data card type 5 that controls the operations has entries in up to seven fields: REGN (1), VLLV (1), CYCNW (1). REGN (2), VLLV (2), CYCNW (2), and REGN (3). If a value is punched for REGN(1) and all other fields are left blank, the yield table will show regeneration by clearcutting. The value entered for REGN(1) is the desired rotation length. YIELD will, however, add a 20-year period to REGN(1) so the final entry in the table will be REGN(1) plus 20. This permits computation of volumes for stands that will not be regenerated until they have passed rotation age. The table may show an intermediate cut at what is really rotation age. For stands cut at or beyond rotation age, the apparent intermediate cut is added to the reported reserve to get correct final volume.

If a value is assigned REGN(2), there must also be values for REGN(1), VLLV(1), and CYCNW(1). A value for REGN(2) and a blank for REGN(3) calls for the seed tree system or two-cut shelterwood. REGN(1) is stand age at time of first cut and REGN(2) is stand age at final cut. VLLV(1) is the percentage of the growing stock level used for intermediate cuts (DLEV) that will remain after the cut at age REGN(1). For example, if DLEV is 100 and VLLV(1) is .50, the residual stand at REGN(1) will have a basal area of 50 square feet. CYCNW(1) is the number of years from REGN (1) to REGN(2).

Assignment of a nonzero value to REGN(3) calls for use of three-cut shelterwood. The first removal cut will occur at age REGN(1), a second cut at REGN(2), and the final cut at REGN(3). VLLV(2), like VLLV(1), is a percentage of the growing stock level DLEV. Now, however, DLEV is not the value read in originally but the level computed with VLLV(1) for the first cut. For example, if the original DLEV is 100 and VLLV(1) and VLLV(2) both equal .50, reserve basal area after the second cut at REGN(2) will be 25 square feet (100 x .5 x .5). Other variables are as explained above.

Preparing input data for the clearcutting option is not complicated. Age at initial thinning (AGEO), interval between cuts (CYCL), and rotation length (REGN(1)) control the operations. Computations proceed until adjusted rotation age is reached. The interval between cuts must be equal to or some multiple of the projection period of the growth and mortality equations (RINT) and a factor of the interval between AGEO and REGN(1).

Tests involving seed tree or shelterwood systems require much more advance planning. Events in the lives of the old and new crops must be scheduled sensibly in relation to each other. The final stand is not removed at or near rotation age but at an older age, the felling age. Length of the rotation becomes the length of the period between similar cuts, and intervening activities must be well described chronologically.

Scheduling of operations may be assisted by drawing a sketch similar to figure 1. The stand shown is managed under a rotation of 110 years, with a final felling age of 140 years.

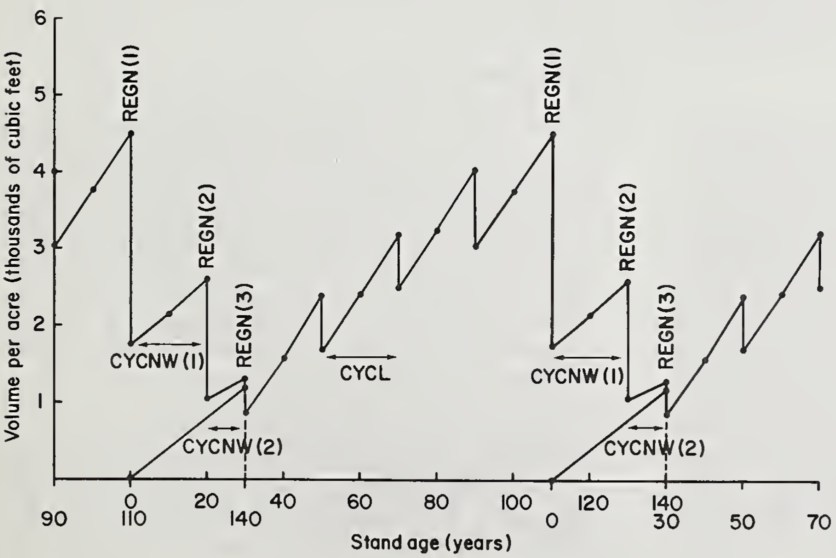

Figure 1.--Volume changes with three-cut shelterwood. Management controls: cutting cycle, 20 years; rotation, 110 years; final felling age, 140 years. Labels are the variable names used in MANGD2.

Intermediate cuts are made at 20-year intervals, with the first thinning at time of the final cut of the overstory. The two removal cuts are 20 years apart. A final cut is made 10 years after the second removal cut. Inspection of the sketch shows that overstory and understory operations occur in proper relation to each other and that similar events occur at intervals equal to the 110-year rotation desired.

It is often desirable to make simulations more realistic by varying the values estimated by equations or contained in tabulations. For example, repeated computations of DBHO without change in values of the independent variables will always give the same numerical result. In reality, actual and estimated values differ frequently. A way of providing variability in estimates of DBHO is contained in the program segment between statements 250 and 300. Similar statements could be written for other variables.

Variability is obtained in three steps: (1) generation of a pseudorandom number, (2) use of this number as an independent variable to compute the value of a residual (range: -0.3 to +0.3 inch), and (3) addition of the residual to the computed value of DBHO. The pseudorandom number generator, statement 250, is of the form:

$$X_i \equiv AX_{i-1} + C \text{ (modulo M)}$$

(Greenberger 1961). Values of all elements of the generator are specified except for X_{i-1}, which is read in as variable GNTR. The statement to compute RES is an empirical distribution function obtained by fitting a polynomial to the normally distributed residuals of the DBHO equation (Evans et al. 1967). An approximation to the normal distribution function may also be used (Burr 1967).

Subroutine VOLS

VOLS is called by subroutine YIELD to compute total cubic feet per acre and the factors used to obtain volumes in other units. Total cubic volumes per acre, from ground line to tip of each tree, are computed from basal area, d.b.h., and tree height by means of stand volume equations. Factors transferred from VOLS are used to convert total cubic volume to other units. With the program listed in appendix 1, factors are obtained for merchantable cubic feet to a 4-inch top and for board feet. Yields in units other than volume, such as by weight (Myers 1960), could also be computed if desired. Total cubic volumes are multiplied by the appropriate factors in subroutine YIELD.

Standards for minimum d.b.h. and top diameters will vary by species and locality. Statements are provided at the end of subroutine YIELD so the limits applicable to yield table volumes will be recorded in table footnotes.

Subroutine CUTS

CUTS is called by subroutine YIELD to determine the increase in average d.b.h. due to thinning to any specified level. The equation for DBHE estimates diameter after thinning when the diameter before thinning and the percentage of trees retained are known (Myers 1971). The percentage of trees that will be retained to reach any specified growing stock level is never known. Successive percentages are therefore tested until d.b.h. after thinning, number of trees, and basal area agree with the desired thinning intensity entered as THIN or DLEV by BASIS1 and as defined in table 1.

Equations for DBHP and SQFT in subroutine CUTS are both expressions for the combinations of diameter and basal area in table 1. Statements for DBHP compute a d.b.h. less than 10.0 inches when the corresponding basal area is known. Statements for SQFT determine basal area when d.b.h. is known. DBHP computes estimates of the diameter required to meet the standards of THIN or DLEV. Basal areas computed with diameters from the equation for DBHE are used in the computations. When DBHP and DBHE are equal to the nearest 0.1 inch, iterations of CUTS terminate and post-thinning basal area (BAST) is computed by SQFT. The ratios GIDE/REST and REST/GIDE in CUTS convert values from growing stock level 80 of table 1 to the levels specified by THIN and DLEV.

Subroutine ANVOL

ANVOL is called once each test to compute volumes per acre for each year from initial thinning to maximum stand age. Volumes in cubic and board feet are obtained by linear interpolation and printed on page type 2. Average stand diameters at each year of stand age are also computed by interpolation of yield table values. Diameters are used later as "independent" variables in computation of the cubic volume obtainable as a byproduct from saw-log cuts.

The last few statements of the routine expand the arrays of volumes removed to assign the volume of each intermediate cut to each of the years before the next cut is made. Volumes cut are added to potential reserve volumes from

the yield table, if necessary, to simulate a complete removal of volume when called for and the yield table shows that partial removals normally occur at that stand age.

Stand age cannot exceed 179 years unless dimensions of the 18- and 180-location arrays of acres and annual volumes are increased.

Subroutine BASIS2

BASIS2 is called once each game to enter numerical values of variables that may differ for each game of a test. Descriptive data include area of the working circle, distribution of area by age classes, nonstocked area, and number of acres to be planted annually. Various costs and the rate at which they change from year to year are also read. One to ten combinations of limiting price, allowable cut, and minimum cutting age are read in for determination of the annual cut. This operation is described by Gould and O'Regan (1965), and in the section of this Paper headed Data Deck. Variables that have zero values at the start of each game are initialized by BASIS2.

Definitions of the variables, restrictions on their values, and other information are also presented in the section that describes the data deck.

Subroutine CHEK2

CHEK2 edits the data cards read by BASIS2 to insure that certain errors do not occur. Terminal indexes of DO loops are checked to be sure they are not smaller than one or larger than the dimensions specified for them or related variables. Variables used in various computations are checked to be sure that they do not have unwanted zero or negative values. Additional statements can be added to further edit the data cards, such as specifying maximum values for various variables.

As with CHEK1, location of an error causes termination of the simulation. A nonzero value for either error flag will cause printing of an error message and end of the job.

Subroutine START

START is called once each game to print a record of conditions for that game. Some of the values read by BASIS1 and BASIS2 are printed on page type 3 under the heading "alternatives for this game." Values that appear elsewhere, such as site index on page type 1, are not printed by START.

Subroutine AREAS

AREAS is called once each game to compute volumes and area distributions at the end of the year before simulation begins. Acres in each 1-year age class are expanded to obtain a record of the age of each individual acre, and are then totaled by 1- and 10-year age classes. Separate records are kept for overstory and understory if seed tree or shelterwood systems are used.

Each acre is assigned an initial treatment status code if seed tree or shelterwood systems are used. Simulation begins as though the same silvicultural system has already been in effect for a number of years. Each overstory acre where regeneration has started has an understory of the appropriate age. The treatment status code controls the timing of future removal or final cuts of the overstory. The code also helps keep appropriate overstory and understory ages together in later list processing operations.

Initial growing stock volume is totaled in board feet and in cubic feet. Volume of an acre will be added to the total of only one of the two volume units. The unit will be board feet if board-foot volume on the acre equals or exceeds the value of the variable BFMRCH read by BASIS1. No volume will be credited to the acre if stand age is less than the specified minimum (AGMRCH).

Volume and money variables that require nonzero values at start of simulation are computed. Each value is then stored in one of two 2-dimensional arrays for printing by REPRT2.

Total area (LAND) cannot exceed 1,000 acres unless the dimensions of AGEOS(I), AGEUN(I), and TRET(I) are increased. Age of the oldest acre cannot exceed 179 years unless dimensions of the 18- and 180-location arrays for acres and volumes are increased.

Subroutine REPRT1

REPRT1 is called several times each game to print a table of the distribution of acres by 1-year and 10-year age classes on page type 4. REPRT1 is called first to record the distribution of acres before simulation begins, as computed by AREAS. It is also called at the end of the first year of each game and at the end of each decade.

Subroutine COVER

COVER is called once each year of each game to increase forested acreage by direct

seeding or planting and to reduce the timbered area by the amount of catastrophic losses. A specified area (IPLNT) is seeded or planted each year, if nonstocked acres exist. Nonstocked acres are those deforested by fire or other catastrophe, and do not include regenerating stands that will restock in the allotted time. Some or all clearcut acres could be added to nonstocked area to simulate delays or failures in natural regeneration.

Understory and overstory age and treatment codes are increased by one when COVER is called at the beginning of each year. Results are the stand ages and treatment codes applicable to that year.

Age of each acre destroyed and added to nonstocked area is selected at random with a pseudorandom number generator of the form:

$$X_i \equiv AX_{i-1} + C \text{ (modulo M)}$$

(Greenberger 1961). All values are present in the FORTRAN statement except for X_{i-1}. This term is the variable ANUL, read from the data deck by subroutine BASIS2. The generator in COVER has a periodicity of 128. Any value of ANUL from 0 to 127 may be read by BASIS2, to vary the pattern of loss. As listed in appendix 2, the sawtimber on any acre destroyed will be salvaged if it is not less than a specified minimum volume (BFSALV). Stands with less than minimum board-foot volumes will be cleaned up at a predetermined cost per acre (CLOSS) unless stand age is equal to or less than that specified for first thinning (AGEO). Young stands are assumed to have no material to be salvaged or that will require cleanup before planting. All these limits may be changed, if desired, to better apply to local conditions and management practices.

COVER was written to provide for the loss of whole acres only. Partial acres lost will be accumulated until an entire acre can be zeroed out in the age and treatment arrays. If very high annual losses are assumed, appropriate parts of COVER will be repeated until all but fractional acres are accounted for.

After each acre selected by the pseudorandom number generator is destroyed, it is put at the end of the sequence of acres arranged according to age. This is necessary because the subroutines that simulate regeneration cuts will select the acre with the oldest eligible stand for cutting first.

Subroutine HRVST

HRVST is called once each year to perform any scheduled intermediate and regeneration cuts. Stand ages at time of intermediate cuts are determined by age at first thinning (AGEO) and interval between treatments (CYCL). Ages of stands to receive regeneration cuts are specified by values of REGN(I) and FMRCHD(I).

Allowable annual cut is the number of acres to be regenerated by clearcutting or to receive the first regeneration cut of the seed tree or shelterwood systems. The annual cut equals the constant or variable allowable limit less any losses of one or more entire acres. Determination of the allowable limit is described in the section headed Data Deck. Regeneration cuts are performed by calls to subroutines CLEAR or SHWD.

Every acre of appropriate age is thinned, regardless of whether or not the volume to be removed exceeds minimum commercial limits. Thinning cost (CTHN) will be assessed against each acre receiving a noncommercial operation. Yields will be determined in board feet if the amounts removed equal or exceed minimum limits for board feet. Otherwise, commercial cuts will be measured in cubic feet of roundwood. If the main cut is credited to board-foot volume, an additional amount in cubic feet will be determined as merchantable volume not in saw logs.

Subroutine CLEAR

CLEAR is called annually by subroutine HRVST if needed to perform regeneration cuttings by the clearcutting system. As explained above, this system is specified by punching only one nonzero felling age on the type 5 data card. The number of acres to be regenerated during the year is computed in HRVST.

As with thinnings, commercial volumes removed will be recorded in board feet if not less than the minimum commercial board-foot cut. Otherwise, the volume will be computed in cubic feet. With board-foot yields, the cubic feet of roundwood not in saw logs will also be determined.

Subroutine SHWD

SHWD is called annually if needed by subroutine HRVST to perform regeneration cuttings

by the seed tree or shelterwood systems. Harvested volumes will be determined in cubic feet or in board feet and cubic feet, as in subroutine CLEAR. As each acre is cut, the treatment status code is changed so future regeneration cuts on the area will be scheduled correctly.

Subroutine ARNG is called by SHWD, as described below.

Subroutine ARNG

ARNG is called periodically by subroutine SHWD to rearrange the sequence in which individual acres are stored in age and treatment code arrays. During a simulation run, young overstories are created in two ways: (1) by removal of the previous overstory, and (2) by replacement of stands destroyed by catastrophe. During rearrangement, overstories of equal age are brought together in the age and treatment arrays. All stands will then be regenerated in proper sequence when treated in order of age during long simulation periods.

Subroutine SUMS

SUMS is called once each year of each game to perform the following operations: (1) compute growing stock volume at the end of the year, (2) determine the number of acres in each 1-year and 10-year age class, (3) compute the costs and returns resulting from the year's activities, and (4) increase all costs by the desired annual rate, if one has been specified in the data deck.

Subroutine ANUAL

ANUAL is called each year of each game to compute 40 volume, area, or money totals and to store them for later use. Each total is stored in one of two 2-dimensional arrays. The first dimension identifies the variable, the second the year of a game to which the value applies. Numerical value of each year subscript is year plus one, so year zero of a game can be included in the array. Array values are used in the three subroutines described below.

Subroutine REPRT2

REPRT2 is called at the end of each game to print the results of each year of the game. Array values computed and stored by ANUAL are printed in 40 numbered columns that extend across four (five with shelterwood) pages of page type 5 (appendix 2). Entries under column headings are printed at the rate of 40 lines, or years, per page.

Subroutine WORTH

WORTH is called at the end of each game to discount all costs incurred and all income received. Value of the growing stock at the end of the simulation period is discounted to beginning of the period. The program discounts each future value at each of 20 compound interest rates. Rates range from 1.0 to 10.5 percent at intervals of 0.5 percent. The limits and interval can be changed by modification of statements for CRATE(I) and CRATE(K) in the first set of statements after the initializing operations. The subroutine will produce 20 rates unless changes are made in the dimension statement and the terminal indexes of the DO loops.

WORTH prints a table that gives the present value of each of the following for each discount rate: (1) future growing stock, (2) all incomes, (3) sum of items 1 and 2, (4) all costs, and (5) item 3 minus the sum of item 4 and the value of the growing stock at beginning of the game. Net discounted revenues (present worths, item 5) may be plotted over discount rates to determine the internal rate of return applicable to the duration and conditions of the game.

Subroutine SUMRY

SUMRY may be called at the end of each test to summarize results of the games of the test. If this option is used, SUMRY is also called at the end of each game to store specified volume or money values in a 3-dimensional array. Values stored correspond to the columns of REPRT2 that have their column numbers entered as KOL(I) by BASIS1. Any of the 40 numbered columns of REPRT2 (appendix 2) may be reproduced. Not more than six columns may be summarized for one test unless the dimensions of variables KOL(I) and SUMM(I,J,K) are increased. The statement that causes reading of KOL(I) by BASIS1 must also be changed. As listed in appendix 1, results of as many as 10 games may be summarized at one time.

Summaries of the games of a test are produced together as the final output of the test. A separate page of page type 7 is printed for each variable (column) selected in advance.

Data Deck

Fourteen types of punch cards, listed below, are used to enter initial values of variables into computer memory. Most cards are not optional and must be included in the data deck so READ statements will be executed properly. Three types are optional (7, 8, 10) and are omitted from the data deck if the options are not to be exercised.

Data cards are read by three routines in the order in which the types are numbered. The type 1 card is read once by the main program to enter BATCH name and the number of tests to be performed in the batch. These identify the job and control the number of times the rest of the main routine is repeated.

Card types 2 to 8, inclusive, are read by BASIS1. One card of each type except types 7 and 8 must be read once each test. Card types 7 (15 cards) and 8 (15 cards) are omitted from the data deck if their options are not to be used. Nonzero stumpage prices (BDPRI and/or CFPRI) on card type 6 cause the corresponding READ statements for variable prices of card types 7 or 8 to be skipped.

Card types 9 to 14, inclusive, are read by BASIS2 once each game. Each type consists of one card except for optional type 10, which requires 10 punch cards. Statements that refer to card type 10, variable area by age classes, are bypassed when a nonzero value is punched for KAREA on card type 9.

Card types 11, 12, and 13 contain values for the price control procedure of Gould and O'Regan (1965). The number of acres harvested annually can be made to vary with the current stumpage price of saw logs. For example, as shown on page type 3 of the second game of the test problem (appendix 2), 5 acres will be cut if price per thousand board feet does not exceed \$12.00. Eight acres will be cut if stumpage price is \$12.01 to \$15.00, and 12 acres will be cut if price exceeds \$15.00 but is less than \$99.00. The \$99.00 value is merely an arbitrary upper limit that prices will not reach. Minimum cutting age can also vary with stumpage price if the clearcutting option is used.

Sequence of regeneration cuts is from oldest acre to youngest, so full allowable cut will be taken only if sufficient acres above minimum cutting age are available. If price control is not wanted, entries for allowable cut in columns 1 to 4 of card type 12 and for cutting age in columns 1 to 8 of card type 13 are the desired constant limits. A critical price greater than the largest possible price (for example, \$99.00) is entered in columns 1 to 8 of card type 11.

Whether price control is wanted or not, the potential annual cut will be reduced automatically each time an acre is lost to fire or other catastrophe. The effect is to impose area control by having the total of acres cut and lost equal the annual cutting budget. The reduction of harvestable acres may be prevented, if desired, by removing LOSS from the statement labeled 10 in subroutine HRVST.

Card type 14 enters the costs of various operations and the rate at which these costs may increase annually.

The order in which data cards will be read can be illustrated by a job consisting of two tests with two games per test. The sequence is as follows:

1. The type 1 card for the job.
2. Card types 2 to 8 for the first test.
3. Card types 9 to 14 for game one of the first test.
4. Card types 9 to 14 for game two of the first test.
5. Card types 2 to 8 for the second test.
6. Card types 9 to 14 for game one of the second test.
7. Card types 9 to 14 for game two of the second test.

Any number of tests and games may be performed in one job. Unless modified, subroutine SUMRY cannot report the results of more than 10 games.

Order and Contents of the Data Deck for Program MANGD2

Card type	Optional	Read by	Frequency read	No. of cards	Variable name	Columns	Format	Description of variable
1	NO	Main	Batch	1	BATCH(I)	1-24	3A8	Descriptive name to identify output of one pass through the computer.
					NTSTS	25-28	I4	Number of tests in the batch, each with a yield table.
2	NO	BASIS1	Test	1	SPEC	1-40	5A8	Name of species being examined; for table headings.

Card type	Optional	Read by	Frequency read	No. of cards	Variable name	Columns	Format	Description of variable
					NSP	41-43	I3	Code number of the species being examined. Used to select species-specific relationships.
3	NO	BASIS1	Test	1	DESCR(I)	1-40	5A8	Phrase to describe conditions of one test; to identify output.
					NGAME	41-44	I4	Number of trials (games) to be operated in one test.
					NOYRS	45-48	I4	Number of years simulated in each game. Can be up to 150, but will usually be less.
					NKOLS	49-52	I4	Number of columns of REPRT2 to be printed by SUMRY.
					KOL(I)	53-76	6I4	Numbers of the columns of REPRT2 to be printed by SUMRY. Column numbers, 1 to 40, are given in the column headings of page type 5 (Appendix 2).
4	NO	BASIS1	Test	1	SITE	1-5	F5.0	Site index. Base age and crown classes same as used to derive growth equations.
					CYCL	6-10	F5.0	Interval between intermediate cuts. Equal to or a multiple of RINT.
					RINT	11-15	F5.0	Number of years for which a growth projection is made by the equations in YIELD.
					THIN	16-20	F5.0	Density level after initial thinning at age AGEO. Based on table 1 and procedure given in description of subroutine YIELD. May equal DLEV.
					DLEV	21-25	F5.0	Density level for intermediate cuts after initial thinning. Based on table 1 of this publication and procedure described in YIELD.
					AGEO	26-30	F5.0	Stand age at time of initial thinning. First age given in the yield table.
					DENO	31-35	F5.0	Number of trees per acre at age AGEO.
					DBHO	36-40	F5.2	Average diameter breast high of the stand at age AGEO.
					GIDE	41-45	F5.0	Base level of set of growing stock levels, as the 80.0 shown in the example of appendix 2.
5	NO	BASIS1	Test	1	REGN(1)	1-8	F8.3	Stand age when first regeneration cut will occur. Must not be zero or blank as this is rotation length for clearcutting.
					VLLV(1)	9-16	F8.3	Percentage of previous DLEV to be left at age REGN(1). Will be zero with clearcutting.

Card type	Optional	Read by	Frequency read	No. of cards	Variable name	Columns	Format	Description of variable
					CYCNW(1)	17-24	F8.3	New interval between cuts in effect after age REGN(1). Will be zero with clearcutting.
					REGN(2)	25-32	F8.3	Stand age at which second regeneration cut, if any, will occur. Removal of seed trees or second cut of shelterwood.
					VLLV(2)	33-40	F8.3	Percentage of previous DLEV (including effect of VLLV(1) to be left at age REGN(2). Will be zero if REGN(3) equals zero.
					CYCNW(2)	41-48	F8.3	New interval between cuts in effect after REGN(2). Will be zero if REGN(3) equals zero.
					REGN(3)	49-56	F8.3	Stand age at which third regeneration cut, if any, will occur. Final cut of 3-cut shelterwood.
6	NO	BASIS1	Test	1	AGMRCH	1-5	F5.0	Minimum stand age for an acre to be included in growing stock volume.
					BFMRCH	6-10	F5.2	Minimum volume in M bd. ft. for an acre to be included in board-foot growing stock volume.
					BFSALV	11-15	F5.2	Minimum volume per acre in M bd. ft. for commercial salvage after fire, wind, or other loss.
					COMCU	16-20	F5.0	Minimum cut per acre in merchantable cubic feet for a cut to be of positive commercial value.
					EXTCU	21-25	F5.0	Minimum commercial cut per acre in merchantable cubic feet when by-product of sawlog operation.
					COMBF	26-30	F5.2	Minimum cut per acre in M bd. ft. for a cut to be of positive commercial value.
					BFPCT	31-35	F5.3	Ratio, as a decimal, of board-foot stumpage values of thinnings to board-foot stumpage values of harvests.
					CFPCT	36-40	F5.3	Ratio, as a decimal, of cubic-foot stumpage values of thinnings to cubic-foot stumpage values of harvests.
					GNTR	41-45	F5.0	Any number between 0 and 1023 used to generate random element of the increase from DBHT to DBHO. Enter number larger than 1024 to bypass this step.

Card type	Optional	Read by	Frequency read	No. of cards	Variable name	Columns	Format	Description of variable
					BDPRI	46-50	F5.2	Stumpage price per M bd. ft. of final harvest if price is constant for all years of a game. Enter zero if variable prices will be entered with card type 8.
					CFPRI	51-55	F5.2	Stumpage price per 100 cubic feet of final harvest if price is constant for all years of a game. Enter zero if variable prices will be entered with card type 7.
7	YES	BASIS1	Test	15	PRICF(I)	1-80	10F8.3	Stumpage price per 100 cubic feet of harvest for each of 150 years. Used when CFPRI equals zero.
8	YES	BASIS1	Test	15	PRIBD(I)	1-80	10F8.3	Stumpage price per M bd. ft. of harvest for each of 150 years. Used when BDPRI equals zero.
9	NO	BASIS2	Game	1	GMNAM(I)	1-24	3A8	Descriptive name to identify each game of a test.
					LAND	25-28	I4	Total acres in simulated working circle. Maximum is 1,000 acres.
					MOLD	29-32	I4	Age of oldest stand in the working circle at start of a game. Maximum is 179 years.
					NONSTK	33-36	I4	Number of acres nonstocked at start of a game. Does not include acres harvested the year before simulation begins if regeneration will take place in the allotted time.
					KAREA	37-40	I4	Number of acres in each 1-year age class when there is equal area in each class except for NONSTK.
					IPLNT	41-44	I4	Number of acres of NONSTK regenerated annually by direct seeding or planting at a cost of CPLT per acre.
					DEFOR	45-52	F8.5	Percentage, as a decimal, of the area of forest lost annually to fire, wind, etc.
					ANUL	53-60	F8.5	Any number between 0 and 127 used to begin generation of pseudorandom numbers that represent ages of stands lost to fire or other agency.
10	YES	BASIS2	Game	10	IACRE(I)	1-72	18I4	Acres in each 1-year age class from 0 to not more than 179. Use if constant area KAREA is not wanted. Include NONSTK in IACRE(1) as well as on card type 9.
11	NO	BASIS2	Game	1	PRIDIV(I)	1-80	10F8.3	Limiting prices used to determine annual cut in acres and minimum cutting age.

Card type	Optional	Read by	Frequency read	No. of cards	Variable name	Columns	Format	Description of variable
12	NO	BASIS2	Game	1	MALCUT(I)	1-40	10I4	Allowable annual cut in acres. May vary with PRIDIV(I).
13	NO	BASIS2	Game	1	FMRCHD(I)	1-80	10F8.3	Minimum cutting age. May vary with PRIDIV(I).
14	NO	BASIS2	Game	1	RATE	1-8	F8.3	Rate of annual increase in costs. Enter zero if constant costs are desired. Otherwise, enter percentage as a decimal.
					CPLT	9-16	F8.3	Cost of regenerating 1 acre by seeding or planting.
					CTHN	17-24	F8.3	Cost per acre of noncommercial thinning with stand conditions as specified for the simulation.
					CLOSS	25-32	F8.3	Cost per acre of cleanup after loss due to fire, wind, etc., when volume that can be salvaged is less than BFSALV.
					ACCST	33-40	F8.3	Total per acre for 1 year of the annual costs that can be assessed by area.
					CUCST	41-48	F8.3	Total of the costs that can be assessed against each 100 cubic feet harvested.
					BFCST	49-56	F8.3	Total of the costs that can be assessed against each M bd. ft. harvested.

Modification of MANGD2

The program can be adapted readily for simulations of species other than those represented in the listing of appendix 1. Replacement of, or additions to, statements in subroutines YIELD, VOLS, CUTS, HRVST, CLEAR, and SHWD are needed. The program listing (appendix 1) contains COMMENT statements that name the species-specific statements. Each statement is identified in YIELD because of the length of the subroutine. Elsewhere, the species-specific statements are named at the beginning of the routine.

As stated in the description of MANGD2, each species-specific statement can appear in several versions, one for each species of interest. In the listing of appendix 1, specific statements are given for two species. Space is provided for a third species in the form of dummy CONTINUE statements. The simplest modification for another species is, therefore, to replace the dummy statements with appropriate relationships applicable to the new species.

Species-specific relationships are described briefly below. Additional details on necessary field work and analysis are given elsewhere (Myers 1971).

1. Diameter increase from growth.

Regression analysis of data obtained on temporary and/or permanent plots provides the equation for DBHO in subroutine YIELD. Future average stand d.b.h. is predicted from present stand conditions. For ponderosa and lodgepole pines, present d.b.h., site index, and present basal area per acre are useful variables. The prediction period of the equation is determined by the number of rings measured on increment cores from temporary plots or from the interval between records on permanent plots.

2. **Diameter increase from thinning.**

Change in average stand diameter caused by intermediate cutting is determined by CUTS with the statements for DBHE and PDBHE. Regression analysis of data obtained during repeated trial marking of plots to numerous intensities of cutting is used to obtain the relationships. In CUTS, post-thinning d.b.h. (DBHE) is a function of prethinning d.b.h. and the percentage of trees to be retained. DBHE is computed directly if the percentage of trees to be retained is at least 50 percent. With fewer trees retained, the relationship is highly nonlinear, so PDBHE is computed and its antilogarithm becomes DBHE.

Simulation may be used to supplement the field data, if the results are checked before use (Myers 1971).

3. **Residuals of the DBHO equation.**

Optional computation of random elements to be added to each predicted DBHO is covered in the description of subroutine YIELD. Residuals used to compute the polynomial for RES come from the field data and related regression equation for DBHO described in item one, above (Evans et al. 1967).

4. **Average stand height.**

Heights, ages, and site indexes obtained on plots where height growth apparently has never been reduced by high stand density are used to obtain estimators of HTSO. Heights from good site index curves or tables may supplement or substitute for field data if based on the same crown classes used in the stand volume equation, described below. In MANGD2, average dominant and codominant heights are used wherever stand heights enter calculations.

5. **Increase in average height from thinning.**

Data to compute the relationships for ADDHT in YIELD are obtained the same way as those used to estimate changes in average d.b.h. Repeated trial markings of numerous stands to many reserve levels will provide: (1) initial average height, (2) postthinning average height, and (3) the percentage of trees retained. Relationships for ADDHT compute the amount of change in height, or the difference between prethinning and post-thinning averages, as a function of the percentage of trees retained. The crown classes measured must be the same as for other measures involving height, dominants and codominants in the case of MANGD2.

At each cutting, the current value of ADDHT is added to height before thinning, HTSO, to obtain height after thinning, HTST. It is also added to a cumulative sum of changes, HTCUM, so computed heights before thinning will show the effects of past treatments as well as of increased age.

6. **Noncatastrophic mortality.**

The number of trees that die in a given period is expressed as a percentage of the number of trees alive at the beginning of the period. This percentage, DIED, is estimated in YIELD from average stand d.b.h. and basal area, both at the beginning of the period. Data come from permanent plots and from temporary plots in areas where dead trees were removed a known number of years prior to measurement. Each percentage is converted to a decimal before regression analysis.

Subroutine YIELD produces yield tables for managed stands where density is kept at a reasonable level by repeated thinnings. Reduction in numbers of trees is, therefore, minor and erratic, just as it is in actual thinned stands of ponderosa and lodgepole pines. In fact, a prediction equation could not be found for such stands with an average d.b.h. of 10.0 inches or larger. Thus each mortality equation in YIELD is preceded by a logical IF statement with 10.0 in the comparison.

7. **Stand volume equation.**

The basic volume computation in MANGD2 is the determination of total cubic volume per acre (CUFT) by subroutine VOLS. This is the sum of the cubic-foot volumes from ground line to tip of all trees more than 4.5 feet tall. Volumes in other units are computed by multiplying total cubic-foot volumes by conversion factors.

Plot volumes are determined by appropriate methods in all units of interest, including total cubic feet. Other measurements are also obtained for use in regression analysis. Two forms of stand volume

equation appear in subroutine VOLS. They are:

$$V = (a + b_1D^2H + b_2B) \times N$$

$$V = (a + b_1D^2H) \times N$$

Another form that has proven useful is:

$$V = a + b_1BH + b_2D$$

Where
V = gross total cubic volume per acre.
D = average stand d.b.h. in inches.
H = average height of dominant and codominant trees.
B = basal area per acre in square feet.
N = number of trees per acre.

Two statements are used for each species, because the relationships are not linear over the ranges of BH or D^2H needed for the yield tables. In data for regression analysis for the first two equations, the dependent variable is cubic volume per acre divided by number of trees.

8. **Volume conversion factors.**

Factors to convert total cubic feet to other units are computed by VOLS. Two factors are produced: (1) FCTR to obtain merchantable cubic feet from top of stump to minimum merchantable top, and (2)PROD to obtain volume in board feet. As mentioned previously, relationships for other units of measure or other utilization standards may replace those listed in appendix 1.

Volumes per acre in various units are obtained as described for the previous item. Ratios are then computed, such as: (1) merchantable cubic feet per total cubic foot, and (2) board feet per total cubic foot. These ratios are then used as dependent variables in regression analyses involving average stand d.b.h. and basal area. Several equations for each factor and species are shown in VOLS so the relationships can be expressed by simple linear functions over a wide range of d.b.h.

9. **Cubic feet from saw-log cut.**

The equations for ADD in subroutines HRVST, CLEAR, and SHWD estimate the merchantable cubic feet obtained in the board-foot portion of saw-log cuts. To obtain the basic data, cubic- and board-foot volumes of all trees above minimum size for saw-logs are summed to obtain equivalent volumes per acre. Tree data come from the same plots used for other volume items described above. Dependent variable for regression analysis is merchantable cubic feet per thousand board feet. Independent variables for the pines used as examples are average d.b.h. and thousands of board feet per acre.

The equation for ADD is used as follows:

1. Cubic volume contained in saw logs is computed.
2. This volume is subtracted from the entire amount of merchantable cubic feet in the cut.
3. The difference is used in computations as the cubic volume obtainable as a byproduct of the saw-log operation.

Possible modifications of MANGD2 for purposes other than changes of species are given in the description of the appropriate subroutine.

An Application of MANGD2

The test problem that follows, demonstrates most computations possible with MANGD2 and the printed results obtained. It may be used to verify accuracy of source decks and compatibility of the program with locally available compilers. The data deck is listed in figure 2. Although the growth projections use relationships applicable to Black Hills ponderosa pine, costs and prices are hypothetical. Results of the simulation are therefore examples only, and do not apply to any real forest area.

Assume an area of 885 acres of managed ponderosa pine stands that range from 0 (just harvested) to 139 years old at the end of a year of operations. Management is by 3-cut shelterwood, with controlling stand ages and intervals as shown in figure 1. Overstory stands range in age from 30 to 139 years old, with 8 acres in each 1-year age class. Understory stands range from 0 (understory absent) to 29 years old. There are 8 acres in each 1-year age class of the understory, including age 0, plus an additional 645 acres of age 0 where understory does not exist. Understories are established where overstory stands are 111 to 139 years old. There are 5 acres of old burn and windthrow that will be seeded or planted at the rate of one acre annually. Annual losses to fire, wind, and other agencies average 0.04 percent of the forested area. Site index of all acres is 70 feet (base age 100 years).

```
SHELTERWOOD TEST          1
BLACK HILLS PONDEROSA PINE                        1
MANAGED, THINNED AT AGE 30.                        2  30    2  10   40
   70   20   10  120  100   30  950   48     80
  110        50    20      130         50    10       140
   40  15    15   300  100  15    85  1    2222  0     25
   1450     1520     1780     1680     1340     1410     1740     1180     1110     1220
   1290     1010      830      900     1090     1390     1310     1190     1270     1570
   1360     1210     1520     1610     1670     1960     1850     1470     1550     1710
   1300     1220     1340     1420     1210     1010     1090     1300     1620     1520
   1510     1620     1960     1730     1770     1730     1560     1690     1810     1610
   1450     1570     1830     1730     1390     1460     1790     1230     1160     1270
   1340     1060      880      950     1140     1440     1360     1240     1320     1620
   1410     1260     1570     1660     1720     2010     1900     1520     1600     1760
   1350     1270     1390     1470     1260     1060     1140     1350     1670     1570
   1560     1670     2010     1780     1820     1780     1610     1740     1860     1660
   1550     1620     1880     1780     1440     1510     1840     1280     1210     1320
   1390     1110      930     1000     1190     1490     1410     1290     1370     1670
   1460     1310     1620     1710     1770     2060     1950     1570     1650     1810
   1400     1320     1440     1520     1310     1110     1190     1400     1720     1620
   1610     1720     2060     1830     1870     1830     1660     1790     1910     1710
EQUAL AREAS CUT ANNUALLY 885 139    5    8    1   0004   21
   99        0        0        0        0        0        0        0        0        0
   8    0    0    0    0    0    0    0    0    0
  110        0        0        0        0        0        0        0        0        0
     01     30       25       25        20      05       156
VARY CUT WITH PRICE         885 139    5    8    1   0004   21
   12       15       99        0        0        0        0        0        0        0
   5    8   12    0    0    0    0    0    0    0
  110      110      110        0        0        0        0        0        0        0
     01     30       25       25        20      05       156
```

Figure 2.--Data deck for test problems.

Stands will be regenerated by 3-cut shelterwood and will be thinned at 20-year intervals, beginning with a precommercial cut at age 30. Shelterwood after the first regeneration cut will have half the basal area that would be left if the operation were an intermediate cut. Basal area retained after the second regeneration cut will be half that left after the first cut. Stands 30 years old on land of site index 70 are expected to have 950 trees per acre that average 4.8 inches in diameter. Initial thinning will be to level 120 or 120/80 times the basal areas in table 1. Subsequent intermediate cuts will be to level 100, or 100/80 times tabulated basal areas.

Values in the first line of the yield table describe stand conditions just prior to initial thinning. To increase the realism of simulations, it is necessary to have some knowledge of what may be expected for various combinations of stand conditions. Actual unthinned, young stands can be examined to determine, for each site index class, the average d.b.h. resulting from various combinations of stand age and number of trees per acre. Influence of an overstory is included, as necessary, where shelterwood or seed tree systems are used. The combination of d.b.h., density, and site index selected for the first line of the table will be the one that best represents the regeneration goal for the working group.

Potential prices of two products have been estimated for each of the next 30 years. The stumpage price of 100 cubic feet of roundwood from mature trees or from thinnings is expected to be $2.50 throughout the period. Price of a thousand board feet of mature saw logs is expected to vary annually, as shown in column 28 of page type 5 of the printout of annual results (appendix 2). Saw logs from thinnings will sell for 85 percent of the price of logs from regeneration cuts. A minimum commercial cut of saw logs will be 1,500 board feet per acre. Minimum commercial cuts per acre of roundwood will be 300 cubic feet from roundwood sales and 100 cubic feet as a byproduct from saw-log operations.

Current value of the growing stock will be computed only for stands at least 40 years old.

Value will be computed for cubic volume for acres with less than 1,500 board feet. Otherwise board-foot volumes will be used.

Present costs of various operations are as follows:

- Costs per acre—
  - Seeding—$30.00
  - Precommercial thinning—$25.00
  - Cleanup where salvage is not possible—$25.00
  - Annual costs—$0.20
- Costs assessed against volume sold—
  - Per 100 cubic feet—$0.05
  - Per thousand board feet—$1.56

These costs are expected to increase at a rate of 1 percent annually. Resources are available to seed 1 acre each year.

Two possible means of setting the allowable annual cut are to be tested. One alternative is to harvest 8 acres annually, less any catastrophic losses, regardless of price fluctuations. A second possibility is to harvest: (1) 5 acres if stumpage price per thousand board feet is $12.00 or less, (2) 8 acres if the price is $12.01 to $15.00, and (3) 12 acres if price exceeds $15.00 per thousand. Regeneration will not be started in stands less than 110 years old.

Periodic production in board feet and total net worth will be compared. Values needed to obtain rates earned will be computed.

Data cards to enter the above values into computer memory must contain the alphameric characters shown in figure 2. Card types 7 and 10 are not included in the data deck because the options that require them will be bypassed.

Test conditions and results of the simulations are printed on seven types of pages (appendix 2). The first two types, (1) a yield table, and (2) tables of volumes per acre for each year of stand age, appear once because one test was run. Four types of pages are printed for each of the two games. The seventh type of page appears once at the end of the printout to summarize specified results of the two games.

The two sheets of "alternatives for this game" show the values used in the simulations, including the different allowable cuts and cutting ages tested.

Distributions of acres by age classes (page type 4) appear on two sets of pages, one set for each game. Pages for year zero show 8 acres of overstory in each 1-year age class from 30 to 139 years. Age class zero has an additional 5 acres of nonstocked area. At year zero, there are 8 acres of understory in each 1-year class from 0 to 29 years. Total acres of understory in the zero age class is 653 to account for the acres not in process of regeneration that have only one story (fig. 1). Acreages are the same for both games, because initial distributions were the same.

Type 4 pages are printed at the end of the first year of each game and at the end of each decade. For brevity, only the pages printed after the thirtieth year of each game are reproduced in appendix 2. After 30 years of simulation, losses and direct seeding have modified the pattern of 8-acre units. In addition, area distributions of the second game have been changed by the variable annual cuts.

The fifth type of page is a set of five pages for each game. Values in many of the 40 numbered columns differ between games. Volumes are unequal because of variations in annual cuts of mature timber during the second game. This caused money values to differ from those reported for the first game.

A page of discounted money values, the sixth type of page, is printed for each game. Rate of return was about the same for both games. Both operations were profitable. In addition, the forest would probably be in good condition to produce other products, especially recreation.

Last, specified values from each game were printed together for convenience in interpretation of results. Total volume in board feet of all cuts plus growing stock (column 10) was slightly higher after 30 years where equal areas were cut each year. After the second year, total net worth (column 40) was greater where annual cuts varied with price.

It must be emphasized that results of these or other simulations depend on: (1) duration of the games, (2) values entered for the various variables, (3) assumptions made, and (4) degree to which the system model represents reality.

The above information, additional data, and knowledge of local conditions would help the forest manager decide how he might best conduct his business. Money yields might encourage the manager to vary annual cuts in response to changes in stumpage price. Highly variable annual cuts and equally variable net incomes could suggest that additional simulations be run to test other alternatives. Cost of computer time need not restrict the manager in his search for information. The test problem was compiled and run on a CDC 6400 computer in 66 seconds of central processor time and 47 seconds of input-output time. Times for a similar problem with clearcutting were 63 and 47 seconds, respectively. Opportunities for cost reductions with repeat runs are great. Compilation, avoidable with use of a binary deck for the source program, took 50 seconds of the total central processor time.

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Appendix 1: Listing of Program MANGD2

```
      PROGRAM MANGD2
     1(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C TO SIMULATE MANAGEMENT OF EVEN-AGED TIMBER STANDS.
C ALL STATEMENTS TO BE MODIFIED FOR OTHER SPECIES ARE IN SUBROUTINES
C YIELD, VOLS, CUTS, HRVST, CLEAR, SHWO.
C
C DEFINITIONS OF VARIABLES.
C
C      ACCST = ANNUAL COST PER ACRE.
C      ADO = CUBIC FEET IN SUBSAWLOG TREES OBTAINABLE DURING SAWLOG CUT.
C      ADDHT = CHANGE IN AVERAGE STAND HEIGHT BY THINNING.
C      AGEO = INITIAL AGE IN YIELD TABLE.
C      AGEOS(I) = AGE OF OVERSTORY STAND ON ACRE I, AGE OF ENTIRE STAND
C         FOR CLEARCUTTING.
C      AGEUN(I) = AGE OF UNDERSTORY STAND ON ACRE I.
C      AGMRCH = MINIMUM AGE FOR STAND TO BE INCLUDED IN GROWING STOCK.
C      ANBDF(I) = M BD. FT. PER ACRE AT END OF YEAR I, IN YIELD TABLE.
C      ANCUV(I) = CU. FT. PER ACRE AT END OF YEAR I, IN YIELD TABLE.
C      ANNET = ANNUAL NET INCOME.
C      ANUL = NUMBER BETWEEN D AND 127 USED TO START GENERATION OF
C         PSEUDORANDOM NUMBERS.
C      BASC = BASAL AREA REMOVED PER ACRE, IN YIELD TABLE.
C      BASO = BASAL AREA PER ACRE BEFORE THINNING, IN YIELD TABLE.
C      BAST = BASAL AREA PER ACRE AFTER THINNING, IN YIELD TABLE.
C      BATCH(I) = JOB NAME.
C      BDFC(I) = M BD. FT. REMOVED PER ACRE IN YEAR I, IN YIELD TABLE.
C      BDFO(I) = M BD. FT. PER ACRE BEFORE THINNING IN YEAR I, IN YIELD
C         TABLE.
C      BDFT(I) = M BD. FT. PER ACRE AFTER THINNING IN YEAR I, IN YIELD
C         TABLE.
C      BDPRI = CONSTANT STUMPAGE PRICE PER M BD. FT.
C      BFCST = COSTS PER M BD. FT. HARVESTED.
C      BFMRCH = MINIMUM VOLUME TO BE INCLUDED IN BD. FT. GROWING STOCK.
C      BFPCT = PCT. TO CONVERT BD. FT. PRICE FOR THINNINGS.
C      BFSALV = MINIMUM M BD. FT. FOR COMMERCIAL SALVAGE.
C      CFMC(I) = MERCHANTABLE CU. FT. REMOVED PER ACRE IN YEAR I, IN
C         YIELD TABLE.
C      CFMO(I) = MERCHANTABLE CU. FT. PER ACRE BEFORE THINNING IN YEAR I,
C         IN YIELD TABLE.
C      CFMT(I) = MERCHANTABLE CU. FT. PER ACRE AFTER THINNING IN YEAR I,
C         IN YIELD TABLE.
C      CFPCT = PCT. TO CONVERT CU. FT. PRICE FOR THINNINGS.
C      CFPRI = CONSTANT STUMPAGE PRICE PER 1DD CU. FT.
C      CLOSS = COST OF CLEANUP OF ACRE NOT SALVAGED.
C      COMBF = MINIMUM COMMERCIAL CUT IN M BD. FT.
C      COMCU = MINIMUM COMMERCIAL CUT IN CU. FT.
C      CPLT = PLANTING  COST PER ACRE.
C      CRATE(I) = INTEREST RATES FOR DISCOUNTING.
C      CSTAC = ANNUAL COSTS BASED ON AREA.
C      CSTVL = ANNUAL COSTS FOR VOLUME HARVESTED.
C      CTHN = COST PER ACRE OF PRECOMMERCIAL THINNING.
C      CUCST = COSTS PER 1DO CUBIC FEET HARVESTED.
C      CUFT = TOTAL CUBIC FEET PER ACRE FROM STAND VOLUME EQUATION, IN
C         YIELD TABLE.
C      CUTAGE = MINIMUM CUTTING AGE.
C      CYCL = INTERVAL BETWEEN INTERMEDIATE CUTS.
C      CYCNW(I) = NEW CUTTING CYCLE AFTER REGENERATION CUT I.
C      DBHE = AVERAGE STAND D.B.H. AFTER REMOVAL OF A PERCENTAGE OF THE
C         LIVE TREES.
C      DBHO = AVERAGE STAND D.B.H. BEFORE THINNING, IN YIELD TABLE.
C      DBHT = AVERAGE STAND D.B.H. AFTER THINNING, IN YIELD TABLE.
C      DEFOR = PERCENTAGE, AS A DECIMAL, OF NUMBER OF ACRES LOST ANNUALLY.
C      DENC = TREES REMOVED PER ACRE, IN YIELD TABLE.
C      DENO = TREES PER ACRE BEFORE THINNING, IN YIELD TABLE.
C      DENT = TREES PER ACRE AFTER THINNING, IN YIELD TABLE.
C      DESCR(I) = DESCRIPTION OF TEST CONDITIONS.
C      DIAM(I) = AVERAGE D.B.H. BEFORE THINNING AT STAND AGE I.
C      DIED = PERCENTAGE, AS A DECIMAL, OF TREES THAT DIE DURING PERIOD
C         RINT.
C      DISC(I) = DISCOUNTED VALUE OF FUTURE COSTS.
C      DISG(I) = DISCOUNTED VALUE OF GROWING STOCK.
C      DISI(I) = DISCOUNTED VALUE OF FUTURE INCOMES.
C      DLEV = GROWING STOCK LEVEL FOR SECOND AND SUBSEQUENT THINNINGS.
C      EXTCU = MINIMUM COMMERCIAL CUT IN CU. FT. FROM SAW LOG OPERATION.
C      FCTR = MERCHANTABLE CU. FT. PER TOTAL CU. FT.
C      FMRCHD(I) = MINIMUM CUTTING AGE BASED ON PRICE.
C      GIDE = BASE FOR GROWING STOCK LEVELS, BD.O IN EXAMPLE SHOWN.
C      GMNAM(I) = NAME OF THE GAME.
C      GNTR = PSEUDORANDOM NUMBER GENERATOR. VALUE D TO 1023.
C      GSVALB = DOLLAR VALUE OF BD. FT. GROWING STOCK.
C      GSVALC = DOLLAR VALUE OF CU. FT. GROWING STOCK.
C      GVLBF = GROWING STOCK VOLUME, M BD. FT.
C      GVLCU = GROWING STOCK VOLUME, CU. FT.
C      HTSO = TREE HEIGHT BEFORE THINNING, IN YIELD TABLE.
C      HTST = TREE HEIGHT AFTER THINNING, IN YIELD TABLE.
C      IACRE(I) = ACRES OF WORKING CIRCLE IN EACH 1-YEAR AGE CLASS AT
C         START OF GAME, BASED ON OVERSTORY.
C      IALCUT = NUMBER OF ACRES ALLOWABLE ANNUAL CUT.
C      IGAME = NUMBER OF GAME.
C      IPLNT = NUMBER OF NON-STOCKED ACRES REGENERATED ANNUALLY.
C      ISUM(I) = TOTAL ACRES IN OVERSTORY FOR EACH 1D-YR AGE CLASS I.
C      ITEST = NUMBER OF TEST.
C      IVAR(I,J) = VARIABLES PRINTED BY REPRT2, ITEM I, YEAR J.
C      IYEAR = YEAR WITHIN RUN OF A GAME.
C      KAREA = EQUAL AREA OF OVERSTORY IN EACH 1-YEAR AGE CLASS.
C      KOL(I) = COLUMN NUMBER (FROM REPRT2) PRINTED BY SUMRY.
C      KOUNT = COUNT OF ACRES HARVESTED, PLUS ONE.
C      LAND = TOTAL ACRES IN SIMULATED WORKING CIRCLE.
C      LAST = NUMBER OF LAST ACRE HARVESTED.
C      MALCUT(I) = ANNUAL ALLOWABLE CUT BASED ON PRICE.
C      MOLD = AGE OF OLDEST ACRE IN WORKING CIRCLE AT START OF A GAME.
C      NACOS(I) = ACRES OF OVERSTORY IN EACH 1-YEAR AGE CLASS I.
C      NACUN(I) = ACRES OF UNDERSTORY IN EACH 1-YEAR AGE CLASS I.
C      NGAME = NUMBER OF GAMES PER TEST.
C      NKOLS = NUMBER OF COLUMNS OF REPRT2 TO BE PRINTED BY SUMRY.
C      NONSTK = NONSTOCKED AREA FROM FIRE OR OTHER CATASTROPHE.
C      NOYRS = NUMBER OF YEARS IN A GAME.
C      NSP = CODE NUMBER FOR SPECIES BEING RUN.  USED TO SELECT SPECIES-
C         SPECIFIC RELATIONSHIPS IN SUBROUTINES.
C      NSUM(I) = TOTAL ACRES IN UNDERSTORY FOR EACH 10-YEAR AGE CLASS I.
C      NTSTS = NUMBER OF TESTS IN BATCH.
C      PRET = PERCENTAGE OF TREES RETAINED AFTER THINNING.
C      PREV(I) = PRESENT VALUE OF GROWING STOCK AND INCOMES.
C      PRIBD(I) = STUMPAGE PRICE PER M BD. FT. IN YEAR I.
C      PRICF(I) = STUMPAGE PRICE PER 1DO CU. FT. IN YEAR I.
C      PRIDIV(I) = PRICES USED TO SET POLICY.
C      PROD = BOARD FEET PER TOTAL CUBIC FOOT.
C      PWTH(I) = PRESENT WORTH.
C      RATE = RATE OF ANNUAL INCREASE IN COSTS.
C      REGN(I) = STAND AGE WHEN REGENERATION CUT I OCCURS.
C      RES = RANDOM VALUE FROM DISTRIBUTION OF RESIDUALS OF EQUATION FOR
C         DBHD.
C      RETHV = ANNUAL RETURN FROM FINAL HARVEST.
C      RETRN = ANNUAL INCOME FROM STUMPAGE.
C      RETTH = ANNUAL RETURN FROM THINNINGS.
C      RINT = NUMBER OF YEARS FOR WHICH GROWTH PROJECTION IS MADE.
C      ROTA = OLDEST STAND AGE TO BE GIVEN IN YIELD TABLE.
C      SALVB = TOTAL BOARD-FOOT VOLUME SALVAGED ANNUALLY.
C      SCLOSS = TOTAL ANNUAL COST OF SALVAGE AND CLEANUP.
C      SCPLT = TOTAL ANNUAL PLANTING COST.
C      SCTHN = SUM OF PRECOMMERCIAL THINNING COSTS.
C      SITE = SITE INDEX.
C      SPEC(I) = NAME OF SPECIES FOR WHICH RUN IS BEING MADE.
C      SQFT = BASAL AREA FOR SPECIFIED AVERAGE D.B.H. BASIS GROWING STOCK
C         LEVEL STANDARDS.
C      SUMM(I,J,K) = ARRAY OF IVAR(I,J) AND VAR(I,J) FOR PRINTING BY
C         SUMRY - NUMBER I IN LIST OF COLUMNS, YEAR J, GAME K.
C      TCOST = TOTAL ANNUAL COSTS.
C      THIN = GROWING STOCK LEVEL FOR INITIAL THINNING.
C      TOTC = TOTAL CUBIC FEET REMOVED PER ACRE, IN YIELD TABLE.
C      TOTO = TOTAL CUBIC FEET PER ACRE BEFORE THINNING, IN YIELD TABLE.
C      TOTT = TOTAL CUBIC FEET PER ACRE AFTER THINNING, IN YIELD TABLE.
C      TRET(I) = INDEX TO SHOW CURRENT TREATMENT STATUS OF ACRE I IF
C         CLEARCUTTING NOT USED.
C      VAR(I,J) = VARIABLES PRINTED BY REPRT2, ITEM I, YEAR J.
C      VBHV = BOARD-FOOT VOLUME FROM HARVESTS.
C      VBTH = BOARD-FOOT VOLUME FROM THINNING.
C      VCHV = CUBIC-FOOT VOLUME FROM HARVESTS.
C      VCTH = CUBIC-FOOT VOLUME FROM THINNING.
C      VLBF = VOLUME HARVESTED, M BD. FT.
C      VLCU = VOLUME HARVESTED, CU. FT.
C      VLLV(I) = PERCENT OF PREVIOUS DLEV TO BE LEFT AT REGN(I), ENTERED
C         AS A DECIMAL.
C      YRLOS = NUMBER OF ACRES LOST ANNUALLY.
C      YSDM(I) = AVERAGE D.B.H. AFTER THINNING AT STAND AGE I.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(1B1),ANCUV(1B1),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHD,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(15D),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,1D),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(1B0),BDFO(1BD),CFMC(1B0),CFMO(1B0),CUFT,DBHT,
     1DIAM(1BD),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
     2YSDM(1B0)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(1D),GMNAM(3),IACRE(1B0),IALCUT,IPLNT,IVAR(26,15D),
     2JVAR(15,15D),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(1BD),
     3NACUN(1BD),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,15D),YRLOS
      COMMON AGEOS(1DD0),AGEUN(1DQ0),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(1B),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(10D0),VBHV,VCHV,VLBF,VLCU
C
C READ BATCH INFORMATION FROM CARD TYPE 1.
C
      READ (5,1) (BATCH(I),I=1,3),NTSTS
    1 FORMAT (3A8,I4)
      IF(NTSTS .GT. D) GO TO 1D
      WRITE (6,5)
    5 FORMAT (1H1,////,40X,46HNTSTS NOT A POSITIVE NUMBER GREATER THAN Z
     1ERO.)
      GO TO 1OD
C
C OPERATE SYSTEM FOR DESIRED NUMBER OF TESTS.
C
   10 DO 5D ITEST=1,NTSTS
C
C ENTER AND CHECK DATA FOR A TEST.
C
      CALL BASIS1
      CALL CHEK1
      IF(FLAG1 .GT. D.D) GO TO 6D
      IF(FLAG2 .GT. 0.D) GO TO 75
C
C PRINT YIELD TABLE AND COMPUTE VOLUME FOR EACH YEAR OF STAND AGE.
C
      CALL YIELD
      CALL ANVOL
C
C OPERATE SYSTEM FOR DESIRED NUMBER OF GAMES.
C
      DO 5D IGAME=1,NGAME
```

```
C
C ENTER AND CHECK DATA FOR A GAME.
C
      IYEAR = 0
      CALL BASIS2
      CALL CHEK2
      IF(FLAG1 .GT. 0.0) GO TO 60
      IF(FLAG2 .GT. 0.0) GO TO 75
C
C PRINT INITIAL CONDITIONS FOR EACH GAME.
C
      CALL START
C
C CREATE ACRES IN EACH AGE CLASS.
C
      CALL AREAS
      IF(FLAG1 .EQ. 2.0) GO TO 90
      CALL REPRT1
      IJK = 0
C
C OPERATE SYSTEM FOR DESIRED NUMBER OF YEARS.
C
      DO 40 IYEAR=1,NOYRS
      CALL COVER
      IF(FLAG1 .EQ. 2.0) GO TO 90
      CALL HRVST
      CALL SUMS
C
C PRINT ACRES IN EACH AGE CLASS FOR FIRST YEAR AND AT END OF EACH
C DECADE OF THE GAME.
C
      IF(IYEAR .LE. 1) GO TO 15
      IF(IJK .EQ. 10) GO TO 20
      GO TO 30
   15 IJK = 1
      GO TO 25
   20 IJK = 0
   25 CALL REPRT1
   30 IJK = IJK + 1
      CALL ANUAL
   40 CONTINUE
C
C PRINT VOLUMES AND VALUES FOR EACH YEAR.
C
      CALL REPRT2
      CALL WORTH
C
C SUMMARIZE DESIRED NUMBER OF COLUMNS OF REPRT2.
C
      IF(NKOLS .LE. 0) GO TO 50
      CALL SUMRY
   50 CONTINUE
      GO TO 100
C
C PRINT MESSAGE IF INPUT ERRORS PREVENT RUN.
C
   60 WRITE (6,65)
   65 FORMAT (1H1,////,20X,44HTHIS RUN CANNOT BE MADE WITH INPUT PROVIDE
     1D.)
      WRITE (6,70)
   70 FORMAT (1H0,10X,111HINCORRECT VALUE PROVIDED FOR A VARIABLE LATER
     1USED AS TERMINAL INDEX OF A DO LOOP OR COUNTER OF COMPUTED GO TO.)
      GO TO 80
   75 WRITE (6,65)
   80 IF(FLAG2 .EQ. 0.0) GO TO 100
      WRITE (6,85)
   85 FORMAT (1H0,30X,73HINCORRECT VALUE PROVIDED FOR A VARIABLE LATER U
     1SED IN MAJOR COMPUTATIONS.)
      GO TO 100
   90 WRITE (6,65)
      WRITE (6,95)
   95 FORMAT (1H0,//////,47X,39HYOU WENT BEYOND AGE LIMIT OF 179 YEARS.)
  100 CALL EXIT
      END
```

Subroutine BASIS1

```
      SUBROUTINE BASIS1
C
C TO ENTER VALUES THAT DO NOT CHANGE DURING A TEST.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIPO(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
     2YSOM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHO(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C SET INITIAL VALUES OF ZERO.
C
      DO 1 I=1,6
    1 KOL(I) = 0
      DO 3 I =1,3
      CYCNW(I) = 0.0
      REGN(I) = 0.0
      VLLV(I) = 0.0
    3 CONTINUE
      DO 5 I=1,150
      PRIBO(I) = 0.0
    5 PRICF(I) = 0.0
      DO 10 I=1,181
      ANBDF(I) = 0.0
   10 ANCUV(I) = 0.0
      DO 15 I=1,6
      DO 15 J=1,25
      DO 15 K=1,10
   15 SUMM(I,J,K) = 0.0
      NSP = 0
C
C READ VALUES THAT DO NOT CHANGE DURING A TEST, FROM CARD TYPES 2 TO 6.
C
      READ (5,25) SPEC,NSP
   25 FORMAT (5A8,I3)
      READ (5,30) (DESCR(I),I=1,5),NGAME,NOYRS,NKOLS,(KOL(I),I=1,6)
   30 FORMAT (5A8,9I4)
      READ (5,35) SITE,CYCL,RINT,THIN,DLEV,AGEO,DENO,DBHO,GIDE
   35 FORMAT (7F5.0,F5.2,F5.0)
      READ (5,40) REGN(1),VLLV(1),CYCNW(1),REGN(2),VLLV(2),CYCNW(2),REGN
     1(3)
   40 FORMAT (10F8.3)
      READ (5,45) AGMRCH,BFMRCH,BFSALV,COMCU,EXTCU,COMBF,BFPCT,CFPCT,
     1GNTR,BDPRI,CFPRI
   45 FORMAT (F5.0,2F5.2,2F5.0,F5.2,2F5.3,F5.0,2F5.2)
C
C CREATE ARRAYS OF CONSTANT PRICES OR READ VARIABLE PRICES FROM CARD
C TYPES 7 AND 8.
C
      IF(CFPRI .NE. 0.0) GO TO 50
      READ (5,40) (PRICF(I),I=1,150)
      GO TO 60
   50 DO 55 I=1,150
   55 PRICF(I) = CFPRI
   60 IF(BDPRI .NE. 0.0) GO TO 70
      READ (5,40) (PRIBO(I),I=1,150)
      GO TO 90
   70 DO 80 I=1,150
   80 PRIBO(I) = BDPRI
   90 RETURN
      END
```

Subroutine CHEK1

```
      SUBROUTINE CHEK1
C
C TO CHECK VALUES READ IN BY BASIS1.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBO(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
     2YSOM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHO(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      FLAG1 = 0.0
      FLAG2 = 0.0
      IF(NGAME .LT. 1) FLAG1 = 1.0
      IF(NKOLS .GT. 6) FLAG1 = 1.0
      IF(NOYRS .LT. 1) FLAG1 = 1.0
      IF(NOYRS .GT. 150) FLAG1 = 1.0
      IF(NSP .LT. 1) FLAG1 = 1.0
      IF(AGEO .LE. 0.0) FLAG2 = 1.0
      IF(BFPCT .LE. 0.0) FLAG2 = 1.0
      IF(CFPCT .LE. 0.0) FLAG2 = 1.0
      IF(CYCL .LE. 0.0) FLAG2 = 1.0
      IF(DBHO .LE. 0.0) FLAG2 = 1.0
      IF(DENO .LE. 0.0) FLAG2 = 1.0
      IF(DLEV .LE. 0.0) FLAG2 = 1.0
      IF(GIDE .LE. 0.0) FLAG2 = 1.0
      IF(PRIBO(1) .LE. 0.0) FLAG2 = 1.0
      IF(PRICF(1) .LE. 0.0) FLAG2 = 1.0
      IF(REGN(1) .LE. 0.0) FLAG2 = 1.0
      IF(RINT .LE. 0.0) FLAG2 = 1.0
      IF(SITE .LE. 0.0) FLAG2 = 1.0
      IF(THIN .LE. 0.0) FLAG2 = 1.0
C
C CHECK THAT CYCL IS EQUAL TO OR A MULTIPLE OF RINT.
C
      IXN = CYCL / RINT
      IRINT = RINT
      JCYCL = CYCL
      TEM = JCYCL - IRINT * IXN
      IF(TEM .NE. 0.0) FLAG2 = 1.0
      RETURN
      END
```

Subroutine YIELD

```
      SU8ROUTINE YIELD
C
C TO COMPUTE YIELDS OF MANAGED, EVEN-AGED STANDS.
C CONTAINS SIX SETS OF STATEMENTS THAT ARE SPECIES-SPECIFIC.
C FODTNDTE FORMATS WILL VARY WITH MERCHANTABILITY STANDARDS.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMDN AGEO,AGMRCH,AN8DF(181),ANCUV(181),BFMRCH,BFPCT,8FSALV,CFPCT
     1,CDMBF,CDMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KDLI6),NGAME,NKDLS,NDYRS,NSP,PRIHD(15D),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(18D),BDFO(18D),CFMC(18D),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,RDTA,STAND,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFDR,
     1FMRCHD(1D),GMNAM(3),IACRE(18D),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,15D),KOUNT,LAND,LAST,MALCUT(1D),MDLD,NACOS(18D),
     3NACUN(18D),NDNSTK,PRIDIV(1D),RATE,RETRN,VAR(14,15D),YRLOS
      COMMON AGEOS(1DDD),AGEUN(1000),ANNET,CUTAGE,GSVAL8,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLDSS
     2,SCPLT,SCTHN,TCOST,TRET(100D),V8HV,VCHV,VLBF,VLCU
C
      ADDHT = D.0
      BDFT = D.D
      CFMT = D.D
      HTCUM = D.0
      J8DFC = 0
      JBDFO = D
      J8DFT = 0
      JCFMC = 0
      JCFMO = D
      JCFMT = 0
      DO 1 I=1,18D
      BDFC(I) = 0.D
      BDFD(I) = 0.D
      CFMC(I) = 0.0
      CFMO(I) = 0.D
      DIAM(I) = 0.D
      YSDM(I) = 0.D
    1 CONTINUE
      NAGO = AGEO
      N = AGEO
      CHAC = CYCL
      DZIB = DLEV
C
C DETERMINE OLDEST STAND AGE TO APPEAR IN YIELD TABLES.
C
      DD 5 NA=1,3
      L = 4 - NA
      IF(REGN(L) .EQ. D.D) GO TO 5
      RDTA = REGN(L)
      GO TO 10
    5 CONTINUE
   10 DIAM(N) = DBHO
C
C ALLDW FOR FELLING AGES OLDER THAN RDTATION WITH CLEARCUTTING.
C
      IF(REGN(2) .EQ. D.D) RDTA = ROTA + 20.0
      IF(ROTA .GT. 18D.D) RDTA = 180.D
C
C OBTAIN AVERAGE HEIGHT AND VOLUMES PER ACRE.
C STATEMENTS FOR HTSO ARE SPECIES-SPECIFIC.
C
      8ASO = DENO * D.0054542 * DBHO * DBHO
      GO TO (15,25,35), NSP
   15 IF(AGEO .GT. 55.0) GO TO 20
      HTSO = 0.01441 * AGEO * SITE - 0.12162 * AGEO - 1.50953
      GO TO 60
   20 HTSO = 0.59947 - 61.5D19 / AGEO + 0.80522 * ALOG1D(SITE) + 20.5252
     18 * ALOG10(SITE) / AGEO
      HTSO = 10.0 ** HTSO
      GO TO 60
   25 IF(AGEO .GT. 45.0) GO TO 30
      HTSO = 3.86111 - 0.05979 * AGEO + D.01215 * AGEO * SITE
      GO TO 60
   30 HTSO = 0.334D1 - 33.2866 / AGEO + 0.92341 * ALOG10(SITE) + 6.27811
     1 * ALOG10(SITE) / AGEO
      HTSO = 10.0 ** HTSO
      GO TO 60
   35 CONTINUE
      GO TO 60
   40 CONTINUE
   60 BA = BASO
      HITE = HTSO
      STAND = DENO
      VDM = D8HO
      CALL VOLS
      TOTO = CUFT
      BDFO(N) = CUFT * PROD
      CFMO(N) = CUFT * FCTR
      REST = THIN
C
C ENTER LOOP FOR ALL REMAINING COMPUTATIONS AND PRINTOUT.
C
      DO 500 I=1,100
   65 IF(AGEO .GE. ROTA) GO TO 13D
C
C CHANGE STANDARDS IF A REGENERATION CUT IS DUE.
C
      IF(REGN(2) .EQ. D.O) GO TO 80
      IF(AGEO .LT. REGN(1)) GO TO 8D
      IF(AGEO .NE. REGN(1)) GO TO 70
      DLEV = DLEV * VLLV(1)
      REST = DLEV
      CYCL = CYCNW(1)
      GO TO 8D
   70 IF(AGED .NE. REGN(2)) GD TD 75
      DLEV = DLEV * VLLV(2)
      PEST = DLEV
      CYCL = CYCNW(2)
      GD TO 80
   75 IF(AGEO .NE. REGN(3)) GO TO 80
      DLEV = DLEV * VLLV(3)
      REST = DLEV
      CYCL = CYCNW(3)
C
C INCREASE D.8.H. BY THINNING AND COMPUTE POST-THINNING VALUES.
C
   8D CALL CUTS
      IF(PRET .GE. 1DD.D) GD TD 83
      YSDM(N) = DBHT
      JDENT = (BAST / (0.DD54542 * DBHT * DBHT)) + D.5
      DENT = JDENT
      BAST = 0.D054542 * DBHT * DBHT * DENT
C
C SKIP THINNING IF BASAL AREA BELDW SPECIFIED RESIDUAL.
C
      IF(BAST .LT. 8ASO) GD TO 85
   83 BAST = BASD
      HTST = HTSO
      DENT = DENO
      JDENT = DEND + 0.5
      DBHT = DBHO
      YSDM(N) = DBHT
      TCTT = TOTO
      BDFT = BDFO(N)
      CFMT = CFMD(N)
      GO TO 130
C
C COMPUTE CHANGE IN AVERAGE HEIGHT FROM THINNING.
C STATEMENTS FOR ADDHT ARE SPECIES-SPECIFIC.
C
   85 GO TO (9D,95,10D), NSP
   90 ADDHT = 7.64833 - 3.82286 * ALDG1D(PRET)
      GO TD 12D
   95 ADDHT = 6.7995D - 3.41979 * ALDG1D(PRET)
      GD TO 120
  1DD CONTINUE
  120 HTCUM = HTCUM + ADDHT
      HTST = HTSD + ADDHT
      BA = BAST
      HITE = HTST
      STAND = DENT
      VDM = DBHT
      CALL VOLS
      TOTT = CUFT
      BDFT = CUFT * PRDD
      CFMT = CUFT * FCTR
C
C CHANGE MODE AND ROUND OFF FOR PRINTING.
C
  130 JCYCL = CYCL
      JSITE = SITE
      JDEND = DEND + D.5
      JHTSO = HTSO + 0.5
      JTOTO = TOTO + 0.5
      JBASD = 8ASO + 0.5
      JCFMO = CFMD(N) + D.5
      JBDFO = (BDFO(N) * 0.1) + 0.5
      JBDFO = JBDFO * 1D
      JHTST = HTST + 0.5
      JTOTT = TOTT + 0.5
      JCFMT = CFMT + D.5
      CFMT = JCFMT
      IF(JCFMT .GT. JCFMO) JCFMO = JCFMT
      CFMO(N) = JCFMO
      JBDFT = (BDFT * 0.1) + D.5
      JBDFT = J8DFT * 10
      BDFT = JBDFT
      BDFT = BDFT * 0.0D1
      IF(JBDFT .GT. JBDFO) JBDFO = J8DFT
      BDFO(N) = JBDFO
      BDFD(N) = BDFO(N) * D.D01
      JBAST = BAST + 0.5
      JDENC = JDENO - JDENT
      J8ASC = JBASO - JBAST
      JTDTC = JTOTO - JTOTT
      JCFMC = JCFMO - JCFMT
      IF(JCFMC .LE. D) JCFMC = D
      CFMC(N) = JCFMC
      JBDFC = JBDFD - JBDFT
      IF(JBDFC .LE. D) JBDFC = D
      BDFC(N) = JBDFC
      BDFC(N) = BDFC(N) * 0.DD1
      IF(I .GE. 2) GO TO 180
C
C WRITE HEADINGS FOR YIELD TABLE ON PAGE TYPE 1.
C
      WRITE (6,15D)
  150 FDRMAT (1H1,//,63X,11HPAGE TYPE 1)
      WRITE (6,155) SPEC,JSITE,JCYCL,THIN,DLEV
  155 FORMAT (1HD,27X,48HYIELDS PER ACRE OF MANAGED, EVEN-AGED STANDS OF
     1 ,5A8/1HO,49X,11HSITE INDEX ,I3,1H,,I4,19H-YEAR CUTTING CYCLE/1HD,
     242X,26HTHINNING LEVELS= INITIAL -,F6.D,14H, SUBSEQUENT -,F6.D,//)
      WRITE (6,160)
  16D FORMAT (1HD,25X,38HENTIRE STAND BEFORE AND AFTER THINNING,28X,26HP
     1ERIODIC INTERMEDIATE CUTS)
      WRITE (6,165)
```

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  165 FORMAT (1H0,9X,5HSTAND,10X,5HBASAL,3X,7HAVERAGE,2X,7HAVERAGE,3X,5H
     1TOTAL,3X,9HMERCHANT-,3X,9HSAWTIMBER,9X,5HBASAL,4X,5HTOTAL,3X,9HMER
     2CHANT-,3X,9HSAWTIMBER)
      WRITE (6,170)
  170 FORMAT (1H ,10X,3HAGE,4X,5HTREES,3X,4HAREA,4X,6HD.B.H.,3X,6HHEIGHT
     1,2X,6HVOLUME,2X,11HABLE VOLUME,4X,6HVOLUME,3X,5HTREES,3X,4HAREA,3X
     2,6HVOLUME,2X,11HABLE VOLUME,4X,6HVOLUME)
      WRITE (6,175)
  175 FORMAT (1H ,8X,7H(YEARS),3X,3HNO.,3X,6HSQ.FT.,4X,3HIN.,6X,3HFT.,4X
     1,6HCU.FT.,5X,6HCU.FT.,8X,3HMBF,5X,3HNO.,3X,6HSQ.FT.,2X,6HCU.FT.,5X
     2,6HCU.FT.,8X,3HMBF)
C
C WRITE TABLE ENTRIES OF DIAMETER, VOLUMES, ETC., ON PAGE TYPE 1.
C
  180 WRITE (6,185) AGEO,JDENO,JBASO,DBHO,JHTSO,JTOTO,CFMO(N),BDFO(N)
  185 FORMAT (1H0,9X,F4.0,4X,I5,2X,I4,5X,F5.1,5X,I3,4X,I5,5X,F6.0,5X,F7.
     13)
      IF(AGEO .GE. ROTA) GO TO 510
      WRITE (6,190) AGEO,JDENT,JBAST,DBHT,JHTST,JTOTT,CFMT,BDFT,JDENC,JB
     1ASC,JTOTC,CFMC(N),BDFC(N)
  190 FORMAT (1H ,9X,F4.0,4X,I5,2X,I4,5X,F5.1,5X,I3,4X,I5,5X,F6.0,5X,F7.
     13,4X,I5,3X,I3,5X,I4,5X,F5.0,6X,F7.3)
C
C COMPUTE VALUES FOR EACH PERIOD. THIN AS SPECIFIED ON DATA CARDS.
C
      IK = CYCL / RINT
      DO 450 L=1,IK
      AGEO = AGEO + RINT
      N = AGEO
      IF(AGEO .GT. ROTA) GO TO 510
C
C COMPUTE NEW D.B.H. BEFORE THINNING AND ROUND OFF TO 0.1 INCH.
C STATEMENTS FOR DBHO ARE SPECIES-SPECIFIC.
C
      GO TO (200,205,210), NSP
  200 DBHO = 1.0097*DBHT + 0.0096*SITE - 1.5766*ALOG10(BAST) + 3.3021
      GO TO 240
  205 DBHO = 1.0222*DBHT + 0.0151*SITE - 1.2417*ALOG10(BAST) + 2.1450
      GO TO 240
  210 CONTINUE
  240 IDBHO = DBHO * 10.0 + 0.5
      DBHO = IDBHO
      DBHO = DBHO * 0.1
C
C ADD RANDOM ELEMENT TO PREDICTED DBHO, IF DESIRED.
C STATEMENT FOR RES IS SPECIES-SPECIFIC.
C
      IF(GNTR .GT. 1024.0) GO TO 300
  250 IDIV = (17.0 * GNTR + 3.0) / 1024.0
      NGNTR = GNTR
      GNTR = (17 * NGNTR + 3) - 1024 * IDIV
      IF(GNTR .GT. 1000.0) GO TO 250
      IF(GNTR .LT. 0.0) GO TO 250
      A1 = GNTR * 0.01
      A2 = A1 * A1
      GO TO (255,260,265), NSP
  255 RES = 0.9565 * A1 - 0.0523 * A2 - 0.0063 * A1 * A2 + 0.00084 * A2
     1* A2 - 3.3009
      GO TO 280
  260 RES = 0.2527 * A1 - 0.0669 * A2 + 0.0079 * A1 * A2 - 0.0003 * A2
     1* A2 - 0.4282
      GO TO 280
  265 CONTINUE
  280 IRES = RES
      IF(RES .LT. 0.0) IRES = RES - 0.5
      IF(RES .GT. 0.0) IRES = RES + 0.5
      ADJ = IRES
      DBHO = DBHO + ADJ * 0.1
  300 DIAM(N) = DBHO
C
C REDUCE DENSITY FOR NONCATASTROPHIC MORTALITY.
C STATEMENT FOR DIED IS SPECIES-SPECIFIC.
C
      GO TO (310,315,320), NSP
  310 IF(DBHT .GE. 10.0) GO TO 345
      DIED = 0.00247 + 0.00124 * DBHT + 0.00028 * DBHT * DBHT + 0.000005
     121 * BAST * BAST - 0.0000905 * DBHT * BAST
      GO TO 340
  315 IF(DBHT .GE. 10.0) GO TO 345
      DIED = 0.05285 - 0.01346 * DBHT + 0.00226 * DBHT * DBHT + 0.000006
     16 * BAST * BAST - 0.0001931 * DBHT * BAST
      GO TO 340
  320 CONTINUE
  340 IF(DIED .LT. 0.0) DIED = 0.0
      DENO = DENT * (1.0 - DIED)
      MNK = DENO + 0.5
      DENO = MNK
      GO TO 350
  345 DENO = DENT
  350 BASO = DENO * (0.0054542 * DBHO * DBHO)
C
C OBTAIN AVERAGE HEIGHT AND VOLUMES PER ACRE.
C STATEMENTS FOR HTSO ARE SPECIES-SPECIFIC.
C
      GO TO (370,380,390), NSP
  370 IF(AGEO .GT. 55.0) GO TO 375
      HTSO = 0.01441 * AGEO * SITE - 0.12162 * AGEO - 1.50953
      GO TO 420
  375 HTSO = 0.59947 - 61.5019 / AGEO + 0.80522 * ALOG10(SITE) + 20.5252
     18 * ALOG10(SITE) / AGEO
      HTSO = 10.0 ** HTSO
      GO TO 420
  380 IF(AGEO .GT. 45.0) GO TO 385
      HTSO = 3.86111 - 0.05979 * AGEO + 0.01215 * AGEO * SITE
      GO TO 420
  385 HTSO = 0.33401 - 33.2866 / AGEO + 0.92341 * ALOG10(SITE) + 6.27811
     1 * ALOG10(SITE) / AGEO
      HTSO = 10.0 ** HTSO
      GO TO 420
  390 CONTINUE
      GO TO 420
  395 CONTINUE
  420 HTSO = HTSO + HTCUM
      BA = BASO
      HITE = HTSO
      STAND = DENO
      VDM = DBHO
      CALL VOLS
      TOTO = CUFT
      BDFO(N) = CUFT * PROD
      CFMO(N) = CUFT * FCTR
C
C TEST IF REGENERATION CUT IS DUE.
C
      DO 430 KU=1,3
      IF(AGEO .EQ. REGN(KU)) GO TO 65
  430 CONTINUE
C
C CHANGE MODE AND ROUND OFF FOR PRINTING.
C
      IF(L .EQ. IK) GO TO 460
      KDENO = DENO + 0.5
      KHTSO = HTSO + 0.5
      KBASO = BASO + 0.5
      KTOTO = TOTO + 0.5
      JCFMO = CFMO(N) + 0.5
      CFMO(N) = JCFMO
      JBDFO = (BDFO(N) * 0.1) + 0.5
      JBDFO = JBDFO * 10
      BDFO(N) = JBDFO
      BDFO(N) = BDFO(N) * 0.001
C
C WRITE VALUES FOR END OF PERIOD IF THINNING NOT DUE.
C
      WRITE (6,185) AGEO,KDENO,KBASO,DBHO,KHTSO,KTOTO,CFMO(N),BDFO(N)
      DBHT = DBHO
      BAST = BASO
      DENT = DENO
  450 CONTINUE
  460 REST = DLEV
  500 CONTINUE
C
C WRITE TABLE FOOTNOTES.  CHANGE OR ADD TO FORMAT STATEMENTS FOR OTHER
C MERCHANTABLE LIMITS.
C
  510 IF(REGN(2) .EQ. 0.0) GO TO 530
      WRITE (6,520)
  520 FORMAT (1H0,//,11X,106HTHIS TABLE SHOWS VALUES FOR SEED TREE OR SH
     1ELTERWOOD CUTTING WITH TIMING AND AMOUNTS SPECIFIED PREVIOUSLY.)
      GO TO 550
  530 WRITE (6,540)
  540 FORMAT (1H0,//,11X,85HTHIS TABLE SHOWS VALUES FOR CLEARCUTTING WIT
     1H ANY ROTATION UP TO A SPECIFIED MAXIMUM.)
  550 GO TO (560,575,590), NSP
  560 WRITE (6,565)
  565 FORMAT (1H0,10X,66HMERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LA
     1RGER TO 4-INCH TOP.)
      WRITE (6,570)
  570 FORMAT (1H0,10X,60HBD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER T
     1O 8-INCH TOP.)
      GO TO 650
  575 WRITE (6,580)
  580 FORMAT (1H0,10X,66HMERCH. CU. FT. - TREES 5.0 INCHES D.B.H. AND LA
     1RGER TO 4-INCH TOP.)
      WRITE (6,585)
  585 FORMAT (1H0,10X,59HBD. FT. - TREES 6.5 INCHES D.B.H. AND LARGER TO
     1 6-INCH TOP.)
      GO TO 650
  590 CONTINUE
  650 CYCL = CHAC
      DLEV = DZIB
      AGEO = NAGO
      RETURN
      END
```

Subroutine VOLS

```
      SUBROUTINE VOLS
C
C TO COMPUTE VOLUMES PER ACRE IN VARIOUS UNITS.
C STATEMENTS FOR CUFT, FCTR, AND PROD ARE SPECIES-SPECIFIC.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEDS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS,
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
```

```
      FCTR = 0.0
      PROD = 0.0
C
C COMPUTE TOTAL CUBIC FEET PER ACRE.
C
      D2H = VDM * VDM * HITE
      GO TO (5,15,25), NSP
    5 IF(D2H .GT. 6000.0) GO TO 10
      CUFT = (0.00225 * D2H - 0.00074 * BA + 0.03711) * STAND
      GO TO 70
   10 CUFT = (0.00247 * D2H + 0.00130 * BA - 1.40286) * STAND
      GO TO 70
   15 IF(D2H .GT. 7000.0) GO TO 20
      CUFT = (0.00276 * D2H - 0.00059 * BA - 0.00577) * STAND
      GO TO 70
   20 CUFT = (0.00248 * D2H + 1.96336) * STAND
      GO TO 70
   25 CONTINUE
      GO TO 70
   30 CONTINUE
   70 IF(VDM .LT. 5.0) GO TO 200
C
C OBTAIN CONVERSION FACTORS FOR MERCHANTABLE CUBIC FEET.
C
      GO TO (100,105,110), NSP
  100 IF(VDM .GT. 6.7) GO TO 102
      FCTR = 0.26612 * VDM - 1.12689
      GO TO 140
  102 IF(VDM .GT. 10.4) GO TO 104
      FCTR = 3.46993 - 0.12017 * VDM - 13.41984 / VDM
      GO TO 140
  104 FCTR = 0.99666 - 0.66932 / VDM
      GO TO 140
  105 IF(VDM .GT. 5.75) GO TO 107
      FCTR = 0.30711 * VDM - 1.11042
      GO TO 140
  107 IF(VDM .GT. 9.8) GO TO 109
      FCTR = 2.32307 - 0.06419 * VDM - 7.47890 / VDM
      GO TO 140
  109 FCTR = 0.99659 - 0.61056 / VDM
      GO TO 140
  110 CONTINUE
      GO TO 140
  112 CONTINUE
      GO TO 140
  114 CONTINUE
  140 IF(VDM .LT. 8.0) GO TO 200
C
C OBTAIN CONVERSION FACTORS FOR BOARD FEET SCRIBNER.
C
      GO TO (150,155,160), NSP
  150 IF(VDM .GT. 11.9) GO TO 153
      PROD = 0.87783 * VDM + 0.00660 * BA - 7.27957
      GO TO 200
  153 PROD = 5.10752 + 0.10712 * VDM + 0.00185 * BA - 36.20229 / VDM
      GO TO 200
  155 IF(VDM .GT. 10.0) GO TO 158
      PROD = 2.08874 + 0.18091 * VDM + 0.00045 * BA
      GO TO 200
  158 PROD = 0.16583 + 3.74174 * ALOG10(VDM)
      GO TO 200
  160 CONTINUE
      GO TO 200
  163 CONTINUE
  200 RETURN
      END
```

Subroutine CUTS

```
      SUBROUTINE CUTS
C
C TO ESTIMATE INCREASE IN AVERAGE D.B.H. DUE TO THINNING.
C STATEMENTS FOR DBHE AND PDBHE ARE SPECIES-SPECIFIC.
C CHANGE STATEMENTS FOR DBHP AND SOFT IF OTHER GROWING STOCK SYSTEM IS
C USED.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBO(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFD(180),CFMC(180),CFMD(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIOIV(10),RATF,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      IF(DBHO .LT. 9.4) GO TO 70
C
C COMPUTE D.B.H. IF DBHO IS LARGE ENOUGH FOR BASAL AREA TO REMAIN
C CONSTANT.
C
      PRET = 100.0
      DO 60 KJ=1,100
      GO TO (1,10,20), NSP
    1 IF(PRET .LT. 50.0) GO TO 5
      DBHE = 0.73365 + 1.02008 * DBHO - 0.01107 * (PRET - 50.0) - 0.0001
     14 * (PRET - 50.0) * (PRET - 50.0)
      GO TO 50
    5 PDBHE = 0.49401 + 0.71890 * ALOG10(DBHO) - 0.22530 * ALOG10(PRET)
     1 + 0.12616 * ALOG10(DBHO) * ALOG10(PRET)
      DBHE = 10.0 ** PDBHE
      GO TO 50
   10 IF(PRET .LT. 50.0) GO TO 15
      DBHE = 0.44222 + 1.03170 * DBHO - 0.00816 * (PRET - 50.0) - 0.0000
     19 * (PRET - 50.0) * (PRET - 50.0)
      GO TO 50
   15 PDBHE = 0.37321 - 0.17274 * ALOG10(PRET) + 0.79921 * ALOG10(DBHO)
     1+ 0.09315 * ALOG10(PRET) * ALOG10(DBHO)
      DBHE = 10.0 ** PDBHE
      GO TO 50
   20 CONTINUE
      GO TO 50
   25 CONTINUE
   50 IDBHE = DBHE  * 10.0 + 0.5
      DBHE = IDBHE
      DBHE = DBHE * 0.1
      DENE = DENO * PRET * 0.01
      NDENE = DENE + 0.5
      DENE = NDENE
      BASE = 0.0054542 * DBHE * DBHE * DENE
      NBASE = BASE * 10.0 + 0.5
      BASE = NBASE
      BASE = BASE * 0.1
      TMPY = 0.0054542 * DBHE * DBHE
      TEM = BASE - REST
      IF(KJ .EQ. 1 .AND. TEM .LT. 0.0) GO TO 220
      IF(TEM .LE. TMPY) GO TO 180
      IF(TEM .LT. 4.0) GO TO 55
      PRET = PRET - 1.0
      GO TO 60
   55 PRET = PRET - 0.3
   60 CONTINUE
      GO TO 180
C
C COMPUTE D.B.H. IF BASAL AREA INCREASES WITH D.B.H.
C
   70 PRET = 40.0
      IF(DBHO .GT. 7.0) PRET = 70.0
      DO 175 J=1,100
      GO TO (75,85,95), NSP
   75 IF(PRET .GE. 50.0) GO TO 80
      PDBHE = 0.49401 + 0.71890 * ALOG10(DBHO) - 0.22530 * ALOG10(PRET)
     1 + 0.12616 * ALOG10(DBHO) * ALOG10(PRET)
      DBHE = 10.0 ** PDBHE
      GO TO 145
   80 DBHE = 0.73365 + 1.02008 * DBHO - 0.01107 * (PRET - 50.0) - 0.0001
     14 * (PRET - 50.0) * (PRET - 50.0)
      GO TO 145
   85 IF(PRET .GE. 50.0) GO TO 90
      PDBHE = 0.37321 - 0.17274 * ALOG10(PRET) + 0.79921 * ALOG10(DBHO)
     1+ 0.09315 * ALOG10(PRET) * ALOG10(DBHO)
      DBHE = 10.0 ** PDBHE
      GO TO 145
   90 DBHE = 0.44222 + 1.03170 * DBHO - 0.00816 * (PRET - 50.0) - 0.0000
     19 * (PRET - 50.0) * (PRET - 50.0)
      GO TO 145
   95 CONTINUE
      GO TO 145
  100 CONTINUE
  145 IDBHE = DBHE * 10.0 + 0.5
      DBHE = IDBHE
      DBHE = DBHE * 0.1
      DENE = DENO * (PRET * 0.01)
      NDENE = DENE + 0.5
      DENE = NDENE
      BASE = 0.0054542 * DBHE * DBHE * DENE
      NBASE = BASE * 10.0 + 0.5
      BASE = NBASE
      BASE = BASE * 0.1
      BREAK = 49.9 * REST / GIDE
      IF(BASE .GT. BREAK) GO TO 150
      DBHP = (GIDE / REST) * (0.08682 * BASE) + 0.94636
      GO TO 160
  150 BUST = 66.2 * (REST / GIDE)
      IF(BASE .GT. BUST) GO TO 155
      DBHP = (GIDE / REST) * (0.10938 * BASE) - 0.17858
      GO TO 160
  155 TMPY = BASE * (GIDE / REST)
      TEM = TMPY * TMPY
      DBHP = 19.04740 * TMPY - 0.26673 * TEM + 0.0012539 * TEM * TMPY
     1 - 448.76833
      IF(TMPY .GT. GIDE) DBHP = DBHO + 0.8
  160 IDBHP = DBHP * 10.0 + 0.5
      DBHP = IDBHP
      DBHP = DBHP * 0.1
      IF(DBHP - DBHE) 165,180,170
  165 PRET = PRET * 1.02
      IF(PRET .GT. 100.0) GO TO 220
      GO TO 175
  170 PRET = PRET * 0.98
  175 CONTINUE
  180 DBHT = DBHE
C
C COMPUTE POST-THINNING BASAL AREA.
C
      IF(DBHT .GT. 5.0) GO TO 200
      SOFT = 11.58495 * DBHT - 11.09724
      GO TO 205
  200 IF(DBHT .GE. 10.0) GO TO 210
      TEM = DBHT * DBHT
      SOFT = 7.76226 * DBHT +0.85289 * TEM -0.07952 * TEM * DBHT-3.45624
  205 BAST = (REST / GIDE) * SOFT
```

```
      GO TO 215
  210 BAST = REST
  215 RETURN
  220 PRET = 100.0
      RETURN
      END
```

Subroutine ANVOL

```
      SUBROUTINE ANVOL
C
C TO COMPUTE VOLUMES FOR EACH YEAR OF STAND AGE.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,CDMBF,COMCU,CYCL,CYCNW(3),DBHO,DEND,DESCR(5),DLEV,GIOE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BOFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHO(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLO,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLDS
      COMMON AGEDS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      IROT = ROTA
      INT = RINT
      NVOL = ((IROT - NAGO) / INT) + 1
      K = NVOL - 1
C
C INTERPOLATE BETWEEN VOLUMES IN YIELD TABLE.
C
      DO 1 L=1,K
      DO 1 J=1,INT
      NN = J + NAGO + (L - 1) * INT
      RJ = J - 1
      N = NAGO + (L - 1) * INT
      ANCUV(NN) =CFMO(N)-CFMC(N)+(RJ/RINT)*(CFMO(N+INT)-CFMO(N)+CFMC(N))
      ANBOF(NN) =BDFO(N)-BDFC(N)+(RJ/RINT)*(BOFO(N+INT)-BDFO(N)+BDFC(N))
    1 CONTINUE
C
C WRITE TABLE HEADINGS FOR PAGE TYPE 2.
C
      WRITE (6,5)
    5 FORMAT (1H1,//,61X,11HPAGE TYPE 2)
      WRITE (6,10) SPEC,SITE,CYCL,THIN,DLEV
   10 FORMAT (1H0,40X,25HGROWING STOCK OF MANAGED ,5A8/1H ,46X,10HSITE I
     1NDEX,F5.0,1H,,F5.0,19H-YEAR CUTTING CYCLE/1H ,52X,14HDENSITY LEVEL
     2-,F5.0,1X,3HAND,F5.0)
      WRITE (6,15)
   15 FORMAT (1H0,43X,44HVOLUMES PRESENT PER ACRE AT END OF EACH YEAR)
      WRITE (6,20)
   20 FORMAT (1H ,54X,23HMERCHANTABLE CUBIC FEET/1H0,64X,4HYEAR/1H ,14X,
     16HDECADE,9X,1H0,9X,1H1,9X,1H2,9X,1H3,9X,1H4,9X,1H5,9X,1H6,9X,1H7,9
     2X,1H8,9X,1H9,//)
      K = D
C
C WRITE CUBIC FEET PER ACRE FOR EACH YEAR ON PAGE TYPE 2.
C
      WRITE (6,40) K,(ANCUV(NN),NN=1,10)
   40 FORMAT (1H ,I20,F13.1,9F10.1)
      IJ = (ROTA * 0.1 + 0.5) - 1.D
      DO 45 J=1,IJ
      NN = 10 * J + 1
      WRITE (6,40) J,ANCUV(NN),ANCUV(NN+1),ANCUV(NN+2),ANCUV(NN+3),ANCUV
     1(NN+4),ANCUV(NN+5),ANCUV(NN+6),ANCUV(NN+7),ANCUV(NN+8),ANCUV(NN+9)
   45 CONTINUE
      J = ROTA * 0.1 + 0.5
      ANCUV(IROT+1) = CFMO(IROT)
      WRITE (6,40) J,ANCUV(IROT+1)
C
C WRITE BOARD FEET PER ACRE FOR EACH YEAR ON PAGE TYPE 2.
C
      WRITE (6,60)
   60 FORMAT (1H0,///,55X,23HTHOUSANDS OF BOARD FEET,//)
      WRITE (6,65) K,(ANBDF(NN),NN=1,10)
   65 FORMAT (1H ,I20,F13.3,9F10.3)
      DO 70 J=1,IJ
      NN = 10 * J + 1
      WRITE (6,65) J,ANBDF(NN),ANBDF(NN+1),ANBDF(NN+2),ANBDF(NN+3),ANBOF
     1(NN+4),ANBDF(NN+5),ANBDF(NN+6),ANBDF(NN+7),ANBOF(NN+8),ANBDF(NN+9)
   70 CONTINUE
      J = ROTA * 0.1 + 0.5
      ANBDF(IROT+1) = BDFO(IROT)
      WRITE (6,65) J,ANBDF(IROT+1)
C
C INTERPOLATE BETWEEN COMPUTED DIAM(N) FOR USE BY OTHER ROUTINES.
C
      K = NAGO
      DO 85 J=1,NVOL
      TEM = K
      INT = TEM + RINT
      TEM = INT
      IF(TEM .GT. ROTA) GO TO 87
      DBHO = YSOM(K)
      IF(DIAM(K) .GT. YSDM(K)) DBHO = DIAM(K)
      TMPY = (DIAM(INT) - DBHO) / RINT
      AKTR = 0.D
      KK = K + 1
      DO 80 I=KK,INT
      AKTR = AKTR + 1.0
      DIAM(I) = DBHO + TMPY * AKTR
   80 CONTINUE
      K = INT
   85 CONTINUE
   87 IF(REGN(2) .GT. 0.0) GO TO 90
      NIC = REGN(1) + 1.0
      KU = REGN(1)
      DO 88 I=NIC,IROT
      DIAM(I) = DIAM(KU)
   88 CONTINUE
C
C PROVIDE FOR ANY ACRES BEYOND CUTAGE LEFT UNTHINNED A FEW YEARS.
C
   90 JCYCL = CYCL
      IMI = JCYCL - 1
      DO 95 I=NAGO,IROT,JCYCL
      DO 95 J=1,IMI
      NX = I + J
      IF(NX .GE. 180) GO TO 100
      BOFC(NX) = BDFC(I)
   95 CFMC(NX) = CFMC(I)
  100 RETURN
      END
```

Subroutine BASIS2

```
      SUBROUTINE BASIS2
C
C TO ENTER OR COMPUTE VALUES USED FOR A SINGLE GAME.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGED,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPC
     1,CDMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,RDTA,STAND,VDM,
     2YSOM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,OEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LANO,LAST,MALCUT(10),MOLD,NACDS(180),
     3NACUN(180),NDNSTK,PRIDIV(10),RATE,RETRN,VAR(14,15D),YRLDS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C SET INITIAL VALUES OF ZERO.
C
      CSTAC = 0.0
      CSTVL = 0.0
      IALCUT = 0
      KOUNT = 1
      LAST = 0
      MIX = 0
      RETRN = 0.0
      YRLOS = 0.0
      DO 1 I=1,180
      IACRE(I) = 0
      NACOS(I) = 0
    1 NACUN(I) = 0
      DO 5 I=1,10
      FMRCHO(I) = 0.0
      MALCUT(I) = 0
    5 PRIOIV(I) = 0.0
      DO 10 I=1,15
      DO 10 J=1,150
      JVAR(I,J) = 0
   10 CONTINUE
      DO 15 I=1,26
      DO 15 J=1,150
   15 IVAR(I,J) = 0
      DO 20 I=1,14
      DO 20 J=1,150
   20 VAR(I,J) = 0.0
C
C READ VALUES THAT DO NOT CHANGE DURING A GAME, FROM CARD TYPE 9.
C
      READ(5,25)(GMNAM(I),I=1,3),LAND,MOLD,NONSTK,KAREA,IPLNT,DEFOR,ANUL
   25 FORMAT (3A3,5I4,2F8.5)
      IF(KAREA .EQ. 0) GO TO 35
C
C ENTER EQUAL AREA FOR EACH OVERSTORY AGE CLASS, IF DESIRED.
C
      MDX = CYCNW(1) + CYCNW(2) + 1.0
      NDX = MOLD + 1
      DO 30 I=MDX,NDX
   30 IACRE(I) = KAREA
C
C ADJUST NUMBER OF ACRES IN OLDEST CLASS IF TOTAL AREA NOT MULTIPLE
C OF KAREA.
C
      KDIFF = LAND - (NDX - MDX + 1) * KAREA - NONSTK
      IACRE(NDX) = IACRE(NDX) + KDIFF
      IACRE(1) = IACRE(1) + NONSTK
      GO TO 45
C
C READ UNEQUAL AREAS FROM CARD TYPE 10, IF DESIRED.
C
   35 READ (5,40) (IACRE(I),I=1,180)
```

```
 40 FORMAT (18I4)

READ COSTS AND LIMITATIONS ON CUT FROM CARD TYPES 11 TO 14.

 45 READ (5,50) (PRIOIV(I),I=1,10)
 50 FORMAT (10F8.3)
    READ (5,40) (MALCUT(I),I=1,10)
    READ (5,50) (FMRCHD(I),I=1,10)
    READ (5,50) RATE,CPLT,CTHN,CLOSS,ACCST,CUCST,BFCST
    RETURN
    END
```

Subroutine CHEK2

```
    SUBROUTINE CHEK2

 TO CHECK VALUES ENTERED BY BASIS2.
 CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.

    COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
    COMMON AGEO,AGMRCH,ANBOF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
   1,CDMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
   2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
   3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
    COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
   1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
   2YSOM(180)
    COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
   1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
   2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLO,NACOS(180),
   3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
    COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
   1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
   2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU

    FLAG1 = 0.0
    FLAG2 = 0.0
    IF(LAND .LT. 1) FLAG1 = 1.0
    IF(LAND .GT. 1000) FLAG1 = 1.0
    IF(MOLO .LT. 1) FLAG1 = 1.0
    IF(MOLO .GT. 179) FLAG1 = 1.0
    IF(ACCST .LE. 0.0) FLAG2 = 1.0
    IF(BFCST .LE. 0.0) FLAG2 = 1.0
    IF(CTHN .LE. 0.0) FLAG2 = 1.0
    IF(CUCST .LE. 0.0) FLAG2 = 1.0
    IF(FMRCHD(1) .LE. 0.0) FLAG2 = 1.0
    IF(MALCUT(1) .LE. 0) FLAG2 = 1.0
    IF(PRIOIV(1) .LE. 0.0) FLAG2 = 1.0
    RETURN
    END
```

Subroutine START

```
    SUBROUTINE START

 TO PRINT CONDITIONS OF SIMULATIONS ON PAGE TYPE 3.
 CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.

    COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
    COMMON AGEO,AGMRCH,ANBOF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
   1,CDMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
   2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
   3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
    COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
   1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
   2YSOM(180)
    COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
   1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
   2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLO,NACOS(180),
   3NACUN(180),NONSTK,PRIOIV(10),RATE,RETRN,VAR(14,150),YRLOS
    COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
   1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
   2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU

    DEFOR1 = DEFOR * 100.0
    WRITE (6,5)
  5 FORMAT (1H1,//,54X,11HPAGE TYPE 3/1H0,45X,26HALTERNATIVES FOR THIS
   1 GAME)
    WRITE (6,10) (BATCH(I),I=1,3)
 10 FORMAT (1H ,45X,7HBATCH  ,3A8)
    WRITE (6,15) ITEST
 15 FORMAT (1H ,45X,4HTEST,I4)
    WRITE (6,20) (GMNAM(I),I=1,3)
 20 FORMAT (1H ,45X,6HGAME  ,3A8)
    WRITE (6,25) (DESCR(I),I=1,5)
 25 FORMAT (1H ,45X,5A8,////)
    WRITE (6,30) NOYRS
 30 FORMAT (1H ,45X,24HNUMBER OF YEARS PER GAME,I4,////)
    WRITE (6,35) (PRIOIV(I),I=1,10)
 35 FORMAT (1H ,15HCRITICAL PRICES,12X,10F9.2)
    WRITE (6,40) (MALCUT(I),I=1,10)
 40 FORMAT (1H ,13HALLOWABLE CUT,11X,10I9)
    WRITE (6,45) (FMRCHD(I),I=1,10)
 45 FORMAT (1H ,19HMINIMUM CUTTING AGE,6X,10F9.0,////)
    WRITE (6,50) LAND
 50 FORMAT (1H ,23HACRES IN WORKING CIRCLE,13X,I4,25X,27HCOSTS IN FIRS
   1T YEAR OF GAME)
    WRITE (6,55) ACCST
 55 FORMAT (1H ,69X,17HPER ACRE (ANNUAL),8X,F9.2)
    WRITE (6,60) CUCST
 60 FORMAT (1H ,38HMINIMUM VALUES FOR INCLUSION IN TOTALS,31X,25HPER 1
   100 CU. FT. HARVESTED,F9.2)
    WRITE (6,65) AGMRCH,BFCST
 65 FORMAT (1H ,4X,22HAGE, FOR GROWING STOCK,11X,F4.0,28X,13HPER M BD.
   1 FT.,12X,F9.2)
    WRITE (6,70) BFMRCH,CTHN
 70 FORMAT (1H ,4X,28HM BD. FT., FOR GROWING STOCK,5X,F5.1,27X,13HTHIN
   1 ONE ACRE,12X,F9.2)
    WRITE (6,75) COMCU,CPLT
 75 FORMAT (1H ,4X,27HCU. FT., FOR COMMERCIAL CUT,5X,F5.0,28X,14HPLANT
   1 ONE ACRE,11X,F9.2)
    WRITE (6,80) CDMBF,CLOSS
 80 FORMAT (1H ,4X,29HM BD. FT., FOR COMMERCIAL CUT,4X,F5.1,27X,19HCLE
   1ANUP OF ONE ACRE,6X,F9.2)
    WRITE (6,85) BFSALV,RATE
 85 FORMAT (1H ,4X,22HM BD. FT., FOR SALVAGE,11X,F5.1,23X,25HRATE OF I
   1NCREASE IN COSTS,4X,F9.2)
    WRITE (6,88) EXTCU
 88 FORMAT (1H ,4X,22HCU. FT. IN SAW LOG CUT,10X,F5.0,//)
    WRITE (6,90) IPLNT
 90 FORMAT (1H ,22HACRES PLANTED ANNUALLY,14X,I4,25X,35HRELATIVE VALUE
   1 OF INTERMEDIATE CUTS)
    WRITE (6,95) DEFOR1,CFPCT
 95 FORMAT (1H ,30HPERCENT OF ACRES LOST ANNUALLY,6X,F8.3,25X,23HSTUMP
   1AGE PRICE, CU. FT.,2X,F9.2)
    WRITE (6,100) BFPCT
100 FORMAT (1H ,69X,23HSTUMPAGE PRICE, BD. FT.,2X,F9.2)
    WRITE (6,105) ANUL
105 FORMAT (1H ,29HPSEUDORANDOM NUMBER GENERATOR,5X,F8.1)
    WRITE (6,110) GNTR
110 FORMAT (1H ,34X,F8.1)
    RETURN
    END
```

Subroutine AREAS

```
    SUBROUTINE AREAS
C
C TO CREATE AND CHECK ARRAY OF ACRES BY STAND AGE AND TO COMPUTE VOLUME
C AND VALUE OF INITIAL GROWING STOCK.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
    COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
    COMMON AGEO,AGMRCH,ANBOF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
   1,CDMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
   2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
   3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
    COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
   1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
   2YSOM(180)
    COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
   1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
   2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLO,NACOS(180),
   3NACUN(180),NONSTK,PRIOIV(10),RATE,RETRN,VAR(14,150),YRLOS
    COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
   1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
   2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
    GSVALB = 0.0
    GSVALC = 0.0
    GVLBF = 0.0
    GVLCU = 0.0
    DO 5 I=1,18
    ISUM(I) = 0
  5 NSUM(I) = 0
    DO 10 I=1,1000
    AGEOS(I) = 0.0
    AGEUN(I) = 0.0
    TRET(I) = 0.0
 10 CONTINUE
C
C CONVERT OVERSTORY ACRES IN EACH IACRE(I) TO INDIVIDUAL ACRES.
C ASSIGN UNDERSTORY ACRES IF USING SEED TREES OR SHELTERWOOD.
C
    JK = 0
    DO 20 J=1,180
    IF(JK .GE. LAND) GO TO 25
    IF(IACRE(J) .LE. 0) GO TO 20
    KL = JK + 1
    JK = JK + IACRE(J)
    DO 15 I=KL,JK
    NAC = LAND + 1 - I
    AGEOS(NAC) = J - 1
    IF(REGN(2) .EQ. 0.0) GO TO 15
    IF(AGEOS(NAC) .LE. REGN(1)) GO TO 15
    AGEUN(NAC) = AGEOS(NAC) - REGN(1)
 15 CONTINUE
 20 CONTINUE
C
C ASSIGN TREATMENT STATUS CODE IF SEED TREES OR SHELTERWOOD USED.
C
 25 IF(REGN(2) .EQ. 0.0) GO TO 35
    TEM = REGN(1) - 1.0
    DO 30 I=1,LAND
    IF(AGEOS(I) .LE. TEM) GO TO 30
    LAST = LAST + 1
    IF(AGEOS(I) .LT. REGN(1)) GO TO 30
    TRET(I) = AGEOS(I) - REGN(1) + 1.0
 30 CONTINUE
C
C GET DISTRIBUTION OF ACRES BY AGE. CHECK THAT NO ACRE IS OLDER THAN
C 179 YEARS UNLESS APPROPRIATE DIMENSIONS ARE CHANGED.
C
 35 DO 50 K=1,LAND
```

```
      IF(AGEOS(K) .LE. 179.0) GO TO 40
      FLAG1 = 2.0
      RETURN
   40 LM = AGEOS(K) + 1.0
      NACOS(LM) = NACOS(LM) + 1
      ML = AGEUN(K) + 1.0
      NACUN(ML) = NACUN(ML) + 1
   50 CONTINUE
C
C COMPUTE TOTAL ACRES BY 10-YEAR AGE CLASSES.
C
      DO 60 I=1,18
      DO 60 J=1,10
      NS = 10 * (I - 1) + J
      ISUM(I) = ISUM(I) + NACOS(NS)
      NSUM(I) = NSUM(I) + NACUN(NS)
   60 CONTINUE
C
C COMPUTE VOLUME OF GROWING STOCK. USE CU. FT. IF VOLUME IS LESS
C THAN BFMRCH.
C
      DO 100 M=1,LAND
      IF(REGN(2) .EQ. 0.0) GO TO 80
C
C ADD VOLUME OF UNDERSTORY IF SYSTEM IS SEED TREE OR SHELTERWOOD.
C
      IF(AGEUN(M) .LT. AGMRCH) GO TO 80
      IL = AGEUN(M) + 1.0
      IF(ANBDF(IL) .GE. BFMRCH) GO TO 70
      GVLCU = GVLCU + ANCUV(IL)
      GO TO 80
   70 GVLBF = GVLBF + ANBDF(IL)
C
C ADD IN VOLUME OF MAIN STAND.  IS OVERSTORY IF SYSTEM IS SEED TREE OR
C SHELTERWOOD.
C
   80 IF(AGEOS(M) .LT. AGMRCH) GO TO 100
      IAG = AGEOS(M) + 1.0
      IF(ANBDF(IAG) .GE. BFMRCH) GO TO 90
      GVLCU = GVLCU + ANCUV(IAG)
      GO TO 100
   90 GVLBF = GVLBF + ANBDF(IAG)
  100 CONTINUE
C
C COMPUTE INITIAL NON-ZERO VALUES FOR REPRT2.
C
      IVAR(7,1) = GVLCU + 0.5
      IVAR(8,1) = GVLBF + 0.5
      IVAR(9,1) = IVAR(5,1) + IVAR(7,1)
      IVAR(10,1) = IVAR(6,1) + IVAR(8,1)
      IVAR(11,1) = NONSTK
      VAR(1,1) = PRICF(1)
      VAR(2,1) = PRIBD(1)
      GSVALB = GVLBF * (PRIBD(1) - BFCST)
      GSVALC = (GVLCU * 0.01) * (PRICF(1) - CUCST)
      VAR(13,1) = GSVALC + GSVALB
      VAR(14,1) = VAR(13,1) + VAR(12,1)
      DO 110 I=1,14
      N = I + 11
      JVAR(I,1) = NSUM(I)
  110 IVAR(N,1) = ISUM(I)
      DO 120 I=15,18
      JVAR(15,1) = JVAR(15,1) + NSUM(I)
  120 IVAR(26,1) = IVAR(26,1) + ISUM(I)
      RETURN
      END
```

Subroutine REPRT1

```
      SUBROUTINE REPRT1
C
C TO REPORT DISTRIBUTION OF ACRES BY AGE CLASSES.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C WRITE TABLE HEADINGS FOR PAGE TYPE 4.
C
      DO 120 KU=1,2
      IF(KU .EQ. 2 .AND. REGN(2) .EQ. 0.0) GO TO 120
      WRITE (6,5)
    5 FORMAT (1H1,//,55X,11HPAGE TYPE 4)
      IF(KU .EQ. 2) GO TO 15
      WRITE (6,10)
   10 FORMAT (1H0,40X,38HDISTRIBUTION OF OVERSTORY ACRES BY AGE)
      GO TO 30
   15 WRITE (6,20)
   20 FORMAT (1H0,40X,39HDISTRIBUTION OF UNDERSTORY ACRES BY AGE)
   30 WRITE (6,35) (BATCH(I),I=1,3)
   35 FORMAT (1H ,45X,7HBATCH  ,3A8)
      WRITE (6,40) ITEST
   40 FORMAT (1H ,45X,4HTEST,I4)
      WRITE (6,45) (GMNAM(I),I=1,3)
   45 FORMAT (1H ,45X,6HGAME  ,3A8)
      WRITE (6,50) (DESCR(I),I=1,5)
   50 FORMAT (1H ,45X,5A8)
      WRITE (6,55) IYEAR
   55 FORMAT (1H ,45X,16HYEAR WITHIN GAME,I4,//)
      WRITE (6,60)
   60 FORMAT (1H ,55X,9HAGE(YEAR))
      WRITE (6,70)
   70 FORMAT (1H ,4X,11HAGE(DECADE),8X,1H0,7X,1H1,7X,1H2,7X,1H3,7X,1H4
     1X,1H5,7X,1H6,7X,1H7,7X,1H8,7X,1H9,10X,5HTOTAL,//)
C
C WRITE NUMBER OF ACRES IN EACH 1-YEAR AGE CLASS AND THE TOTALS OF
C 10-YEAR CLASSES ON PAGE TYPE 4.
C
      DO 100 J=1,18
      IK = J - 1
      NN = 10 * IK + 1
      IF(KU .EQ. 2) GO TO 90
      WRITE (6,80) IK,NACOS(NN),NACOS(NN+1),NACOS(NN+2),NACOS(NN+3),NA
     1S(NN+4),NACOS(NN+5),NACOS(NN+6),NACOS(NN+7),NACOS(NN+8),NACOS(NN
     2),ISUM(J)
   80 FORMAT (1H ,I11,5X,10I8,I15,/)
      GO TO 100
   90 WRITE (6,80) IK,NACUN(NN),NACUN(NN+1),NACUN(NN+2),NACUN(NN+3),NA
     1N(NN+4),NACUN(NN+5),NACUN(NN+6),NACUN(NN+7),NACUN(NN+8),NACUN(NN
     2),NSUM(J)
  100 CONTINUE
  120 CONTINUE
      RETURN
      END
```

Subroutine COVER

```
      SUBROUTINE COVER
C
C TO SIMULATE ANNUAL CHANGES DUE TO PLANTING OR FIRES.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFP
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VOM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      GVLBF = 0.0
      GVLCU = 0.0
      LOSS = 0
      NPLNT = 0
      RETHV = 0.0
      RETTH = 0.0
      SCLOSS = 0.0
      SCPLT = 0.0
      SCTHN = 0.0
      VLBF = 0.0
      VLCU = 0.0
      JCYCL = CYCL
      IYRM = IYEAR + 1
C
C MAKE ANY SCHEDULED ANNUAL SEEDING OR PLANTING.
C
      IF(NONSTK .EQ. 0) GO TO 5
      NPLNT = IPLNT
      IF(NPLNT .GT. NONSTK) NPLNT = NONSTK
      NONSTK = NONSTK - NPLNT
      APLT = NPLNT
      SCPLT = APLT * CPLT
      IF(NONSTK .EQ. 0) GO TO 5
      IF(REGN(2) .GT. 0.0) GO TO 1
      KIM = LAND - NONSTK + 1 + LAST
      IF(KIM .GT. LAND) KIM = KIM - LAND
      GO TO 3
    1 KIM = LAND - NONSTK + 1
    3 ICH = KIM + NONSTK - 1
C
C INCREASE STAND AGES ONE YEAR TO OBTAIN AGES FOR CURRENT YEAR.
C
    5 DO 10 I=1,LAND
      AGEOS(I) = AGEOS(I) + 1.0
   10 CONTINUE
      DO 13 I=1,LAND
      IF(TRET(I) .EQ. 0.0) GO TO 13
      AGEUN(I) = AGEUN(I) + 1.0
      TRET(I) = TRET(I) + 1.0
   13 CONTINUE
      IF(NONSTK .EQ. 0) GO TO 20
C
C SUPPRESS AGE INCREASE FOR NONSTOCKED ACRES.
C
      DO 15 I=KIM,ICH
```

```
      AGEOS(I) = 0.0
      AGEUN(I) = 0.0
   15 CONTINUE
   20 IF(DEFOR .EQ. 0.0) GO TO 100
C
C COMPUTE AREA DEFORESTED ANNUALLY.
C
      AKOX = LAND - NONSTK
      YRLOS = (AKOX * DEFOR) + YRLOS
      IF(YRLOS .LT. 1.0) GO TO 100
C
C GENERATE PSEUDORANDOM NUMBER FOR AGE OF ACRE DESTROYED.
C WITH SEED TREES OR SHELTERWOOD, ALL COMPUTATIONS BASED ON AGE OF
C OVERSTORY.
C
   25 NDIV = (17.0 * ANUL + 3.0) / 128.0
      NULL = ANUL
      NULL = (17 * NULL + 3) - 128 * NDIV
      ANUL = NULL
C
C CHECK THAT AGE EXISTS AND IS BETWEEN ONE AND OLDEST CURRENT AGE.
C
      IF(REGN(2) .EQ. 0.0) GO TO 28
      IF(ANUL .LE. AGEO ) GO TO 25
      GO TO 29
   28 IF(ANUL .LE. 0.0) GO TO 25
      IF(ANUL .GT. AGEOS(KOUNT)) GO TO 25
   29 DO 30 M=1,LAND
      KACR = M
      IF(AGEOS(M) .EQ. ANUL) GO TO 35
   30 CONTINUE
      GO TO 25
C
C SET LOSS TO REDUCE CURRENT ALLOWABLE CUT.
C
   35 LOSS = LOSS + 1
      NONSTK = NONSTK + 1
      YRLOS = YRLOS - 1.0
      IF(REGN(2) .GT. 0.0) GO TO 38
      IF(IYEAR .EQ. 1) LAST = KACR
C
C SALVAGE BOARD-FOOT VOLUME IF NOT LESS THAN BFSALV AND IF AGE IS
C GREATER THAN AGEO.
C
   38 IF(NULL .LE. NAGO) GO TO 50
      IF(IYEAR .EQ. 1) MTHN = FMRCHD(1)
      NULL = NULL + 1
      KULL = NULL - 1
      IF(REGN(2) .EQ. 0.0) GO TO 39
      IF(AGEOS(KACR) .GT. REGN(1) .AND. AGEOS(KACR) .NE. REGN(2)) GO TO
     1 40
   39 IF(KULL .LT. MTHN) GO TO 40
      SALVB = ANBDF(NULL) + BDFC(KULL)
      GO TO 45
   40 SALVB = ANBDF(NULL)
   45 IF(SALVB .GE. BFSALV) GO TO 48
      SCLOSS = SCLOSS + CLOSS
      GO TO 50
   48 VLBF = VLBF + SALVB
      RETTH = RETTH + SALVB * (PRIBD(IYRM) * BFPCT)
C
C RENUMBER ACRES. PUT ACRE LOST AT END OF AGE SEQUENCE WITH AGE ZERO.
C
   50 IF(REGN(2) .GT. 0.0) GO TO 80
      IF(KACR .NE. KOUNT) GO TO 55
      LAST = LAST + 1
      KOUNT = KOUNT + 1
      AGEOS(LAST) = 0.0
      GO TO 100
   55 LUB = LAST - 1
      IF(KACR .LT. LAST) GO TO 70
      MNO = LAND - KACR
      DO 60 J=1,MNO
      JSUB = KACR + J
      ISUB = JSUB - 1
      AGEOS(ISUB) = AGEOS(JSUB)
   60 CONTINUE
      AGEOS(LAND) = AGEOS(1)
      DO 65 K=1,LUB
      KAN = K + 1
      AGEOS(K) = AGEOS(KAN)
   65 CONTINUE
      AGEOS(LAST) = 0.0
      GO TO 100
   70 DO 75 M=KACR,LUB
      MOL = M + 1
      AGEOS(M) = AGEOS(MOL)
   75 CONTINUE
      AGEOS(LAST) = 0.0
      GO TO 90
   80 MNO = LAND - 1
      DO 85 M=KACR,MNO
      MOL = M + 1
      AGEOS(M) = AGEOS(MOL)
      AGEUN(M) = AGEUN(MOL)
      TRET(M) = TRET(MOL)
   85 CONTINUE
      AGEOS(LAND) = 0.0
      AGEUN(LAND) = 0.0
      TRET(LAND) = 0.0
      IF(KACR .LE. LAST) LAST = LAST - 1
C
C REMOVE ANOTHER ACRE IF FIRE LOSS TOTAL STILL ONE ACRE OR MORE.
C
   90 IF(YRLOS .GE. 1.0) GO TO 25
      IF(REGN(2) .GT. 0.0) GO TO 100
      IF(IYEAR .EQ. 1) LAST = 0
C
C PREPARE SUBTOTALS FOR CURRENT YEAR AND CHECK THAT NO ACRE IS OLDER
C THAN 179 YEARS.
C
  100 DO 110 K=1,180
      NACOS(K) = 0
      NACUN(K) = 0
  110 CONTINUE
      DO 130 K=1,LAND
      IF(AGEOS(K) .LE. 179.0) GO TO 120
      FLAG1 = 2.0
      GO TO 140
  120 LM = AGEOS(K) + 1.0
      NACOS(LM) = NACOS(LM) + 1
      ML = AGEUN(K) + 1.0
      NACUN(ML) = NACUN(ML) + 1
  130 CONTINUE
  140 RETURN
      END
```

Subroutine HRVST

```
      SUBROUTINE HRVST
C
C TO SIMULATE ANNUAL CHANGES DUE TO THINNINGS AND REGENERATION CUTS.
C STATEMENTS FOR ADD ARE SPECIES-SPECIFIC.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGD,PRET,PROD,REST,ROTA,STAND,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLO,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,JSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C DETERMINE ALLOWABLE CUT ON BASIS OF BD. FT. STUMPAGE PRICE.
C
      DO 5 J=1,10
      NSUB = J
      IF(PRIBD(IYRM) .LE. PRIDIV(J)) GO TO 10
    5 CONTINUE
   10 IALCUT = MALCUT(NSUB) - LOSS
      CUTAGE = FMRCHD(NSUB)
C
C COMPUTE THINNINGS FOR ANNUAL CUT.
C
      MXY = 0
      MAC = CUTAGE
      DO 70 I=NAGO,MAC,JCYCL
C
C COMPUTE BD. FT. FROM THINNINGS.
C
      VBTH = 0.0
      VCTH = 0.0
      VLBF1 = 0.0
      VLBF3 = 0.0
      VLCU1 = 0.0
      VLCU3 = 0.0
      IF(I .GE. MAC) GO TO 80
      MR = I + 1
      IF(BDFC(I) .LT. COMBF) GO TO 60
      VLBF1 = NACOS(MR) * BDFC(I)
      VLBF3 = NACUN(MR) * BDFC(I)
      VLBF = VLBF + VLBF1 + VLBF3
      VBTH = VLBF1 + VLBF3
      RETTH = RETTH + VBTH * (PRIBD(IYRM) * BFPCT)
      MXY = MXY + 1
C
C CU. FT. NOT IN SAWLOGS INCLUDED IN CU. FT. CUT, IF COMMERCIAL.
C
      GO TO (15,20,25), NSP
   15 ADD = BDFC(I) * (61.79999 + 2677.97761 / DIAM(I) - 4.03445 * BDFC(
     1I))
      GO TO 50
   20 ADD = BDFC(I) * (209.34226 + 298.06217 / DIAM(I) - 0.54225 *
     1 BDFC(I))
      GO TO 50
   25 CONTINUE
   50 ADD = CFMC(I) - ADD
      IF(ADD .LT. EXTCU) GO TO 70
      VLCU1 = NACOS(MR) * ADD
      VLCU3 = NACUN(MR) * ADD
      VLCU = VLCU + VLCU1 + VLCU3
      VCTH = VLCU1 + VLCU3
      RETTH = RETTH + (VCTH * 0.01) * (PRICF(IYRM) * CFPCT)
      GO TO 70
C
C COMPUTE CU. FT. FROM THINNINGS IF BD. FT. CUT IS NONCOMMERCIAL.
C
   60 IF(CFMC(I) .LT. COMCU) GO TO 65
      VLCU1 = NACOS(MR) * CFMC(I)
      VLCU3 = NACUN(MR) * CFMC(I)
      VLCU = VLCU + VLCU1 + VLCU3
```

```
      VCTH = VLCU1 + VLCU3
      RETTH = RETTH + VCTH * 0.01 * (PRICF(IYRM) * CFPCT)
      MXY = MXY + 1
      GO TO 70
   65 MXY = MXY + 1
      SCTHN = NACOS(MR) * CTHN + SCTHN
      SCTHN = NACUN(MR) * CTHN + SCTHN
   70 CONTINUE
   80 MTHN = NAGO + MXY * JCYCL
C
C SELECT APPROPRIATE SUBROUTINE FOR SILVICULTURAL SYSTEM SPECIFIED.
C
      IF(IALCUT .LE. 0) GO TO 100
      IF(REGN(2) .GT. 0.0) GO TO 90
      CALL CLEAR
      GO TO 100
   90 CALL SHWD
  100 RETURN
      END
```

Subroutine CLEAR

```
      SUBROUTINE CLEAR
C
C TO COMPUTE VOLUMES FROM HARVEST BY CLEARCUTTING.
C STATEMENTS FOR ADD ARE SPECIES-SPECIFIC.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BOFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STANO,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      KAI = 0
      DO 140 I=1,IALCUT
      VBHV = 0.0
      VCHV = 0.0
      VLBF2 = 0.0
      VLCU2 = 0.0
      IF(LAST .LT. LAND) GO TO 10
      LAST = 0
   10 LAST = LAST + 1
      IF(AGEOS(LAST) .GE. CUTAGE) GO TO 20
      LAST = LAST - 1
      GO TO 150
   20 M = AGEOS(LAST)
      KAI = KAI + 1
      K = M + 1
      KOUNT = KOUNT + 1
      ISAFE = LAND + 1
      IF(KOUNT .GE. ISAFE) KOUNT = 1
C
C COMPUTE BD. FT. FROM HARVEST CUTS.
C
      IF(M .LT. MTHN) GO TO 30
      VLBF2 = ANBDF(K) + BDFC(M)
      TEM = ANCUV(K) + CFMC(M)
      GO TO 40
   30 VLBF2 = ANBDF(K)
      TEM = ANCUV(K)
   40 IF(VLBF2 .LT. COMBF) GO TO 100
      VLBF = VLBF + VLBF2
      VBHV = VLBF2
      RETHV = RETHV + VBHV * PRIBD(IYRM)
C
C CU. FT. NOT IN SAWLOGS INCLUDED IN CU. FT. CUT, IF COMMERCIAL.
C
      GO TO (50,55,60), NSP
   50 ADD = VLBF2 * (61.79999 + 2677.97761 / DIAM(M) - 4.03445 * VLBF2)
      GO TO 90
   55 ADD = VLBF2 * (209.34226 + 298.06217 / DIAM(M) - 0.54225 * VLBF2)
      GO TO 90
   60 CONTINUE
   90 VCHV = TEM - ADD
      IF(VCHV .LT. EXTCU) GO TO 130
      VLCU = VLCU + VCHV
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
      GO TO 130
C
C COMPUTE CU. FT. FROM HARVEST CUTS IF BD. FT. CUT IS NONCOMMERCIAL.
C
  100 IF(M .LT. MTHN) GO TO 110
      VLCU2 = ANCUV(K) + CFMC(M)
      GO TO 120
  110 VLCU2 = ANCUV(K)
  120 IF(VLCU2 .LT. COMCU) GO TO 140
      VLCU = VLCU + VLCU2
      VCHV = VLCU2
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
  130 AGEOS(LAST) = 0.0
  140 CONTINUE
  150 IF(KAI .LT. IALCUT) IALCUT = KAI
      RETURN
      END
```

Subroutine SHWD

```
      SUBROUTINE SHWD
C
C TO COMPUTE VOLUMES FROM HARVEST BY SEED TREES OR SHELTERWOOD.
C STATEMENTS FOR ADD ARE SPECIES-SPECIFIC.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPC
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DEND,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PRDD,REST,RDTA,STANO,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,OEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      JK = REGN(1) + 1.0
      KJ = REGN(1)
      KAI = 0
      INT = CYCNW(1) + CYCNW(2) - 1.0
      MIX = MIX + 1
      IF(MIX .GT. INT) MIX = 1
C
C MAKE ALLOWABLE CUT OF INITIAL CUTTINGS BY SHELTERWOOD OR SEED TREE
C SYSTEM.
C
      DO 130 I=1,IALCUT
      ADD = 0.0
      VBHV = 0.0
      VCHV = 0.0
      VLBF2 = 0.0
      VLCU2 = 0.0
      IF(LAST .LT. LAND) GO TO 10
      LAST = 0
   10 LAST = LAST + 1
      IF(AGEOS(LAST) .GE. CUTAGE) GO TO 20
      LAST = LAST - 1
      GO TO 140
   20 M = AGEOS(LAST)
C
C COMPUTE BD. FT. FROM INITIAL HARVEST CUTS.
C
      IF(AGEOS(LAST) .GT. REGN(1)) GO TO 30
      VLBF2 = BDFC(KJ)
      VLCU2 = CFMC(KJ)
      GO TO 40
   30 TEM = AGEOS(LAST) - REGN(1)
      IT = REGN(1) + TEM + 1.0
      EXO = ANBDF(IT) - ANBDF(JK)
      VLBF2 = BDFC(KJ) + EXO
      EXT = ANCUV(IT) - ANCUV(JK)
      VLCU2 = CFMC(KJ) + EXT
   40 IF(VLBF2 .LT. COMBF) GO TO 110
      VLBF = VLBF + VLBF2
      VBHV = VLBF2
      RETHV = RETHV + VBHV * PRIBD(IYRM)
      TRET(LAST) = 1.0
      KAI = KAI + 1
C
C CU. FT. NOT IN SAWLOGS INCLUDED IN CU. FT. CUT, IF COMMERCIAL.
C
      IF(M .GT. KJ) M = KJ
      GO TO (50,60,70), NSP
   50 ADO = VLBF2 * (61.79999 + 2677.97761 / DIAM(M) - 4.03445 * VLBF2)
      GO TO 100
   60 ADO = VLBF2 * (209.34226 + 298.06217 / DIAM(M) - 0.54225 * VLBF2)
      GO TO 100
   70 CONTINUE
  100 TEM = VLCU2
      VCHV = TEM - AOD
      IF(VCHV .LT. EXTCU) GO TO 130
      VLCU = VLCU + VCHV
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
      GO TO 130
C
C COMPUTE CU. FT. FROM HARVEST CUTS IF BD. FT. CUT IS NONCOMMERCIAL.
C
  110 IF(VLCU2 .LT. COMCU) GO TO 130
      VLCU = VLCU + VLCU2
      VCHV = VLCU2
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
      TRET(LAST) = 1.0
      KAI = KAI + 1
  130 CONTINUE
C
C ADD VOLUME AND VALUE OF SECOND CUT OF SHELTERWOOD OR SEED TREES TO
C APPROPRIATE YEAR TOTAL.
C
  140 K = REGN(2)
      KK = K + 1
      TMPY = CYCNW(1) + 1.0
      DO 230 I=1,LAND
      IF(TRET(I) .NE. TMPY) GO TO 230
      ADD = 0.0
      VBHV = 0.0
      VCHV = 0.0
      VLBF2 = 0.0
      VLCU2 = 0.0
      M = AGEOS(I)
```

```
      IF(REGN(3) .EQ. 0.0) GO TO 150
      VLBF2 = BOFC(K)
      VLCU2 = CFMC(K)
      GO TO 160
  150 VLBF2 = ANBDF(KK)
      VLCU2 = ANCUV(KK)
C
C COMPUTE BD. FT. FROM SECOND CUTS.
C
  160 IF(VLBF2 .LT. COMBF) GO TO 210
      VLBF = VLBF + VLBF2
      VBHV = VLBF2
      RETHV = RETHV + VBHV * PRIBD(IYRM)
C
C CU. FT. NOT IN SAWLOGS INCLUDED IN CU. FT. CUT, IF COMMERCIAL.
C
      IF(M .GT. K) M = K
      IF(M .EQ. 0) GO TO 220
      IF(DIAM(M) .EQ. 0.0) GO TO 220
      GO TO (170,175,180), NSP
  170 ADD = VLBF2 * (61.79999 + 2677.97761 / DIAM(M) - 4.03445 * VLBF2)
      GO TO 200
  175 ADD = VLBF2 * (209.34226 + 298.06217 / DIAM(M) - 0.54225 * VLBF2)
      GO TO 200
  180 CONTINUE
  200 TEM = VLCU2
      VCHV = TEM - ADD
      IF(VCHV .LT. EXTCU) GO TO 220
      VLCU = VLCU + VCHV
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
      GO TO 220
C
C COMPUTE CU. FT. IF BD. FT. VOLUME NOT COMMERCIAL.
C
  210 IF(VLCU2 .LT. COMCU) GO TO 230
      VLCU = VLCU + VLCU2
      VCHV = VLCU2
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
C
C CHANGE STAND AGE AND STORY DESIGNATION TO MATCH CUT.
C
  220 IF(REGN(3) .GT. 0.0) GO TO 230
      TRET(I) = 0.0
      AGEOS(I) = AGEUN(I)
      AGEUN(I) = 0.0
  230 CONTINUE
C
C ADD VOLUME AND VALUE OF THIRD CUT OF SHELTERWOOD TO APPROPRIATE YEAR
C TOTAL.
C
      IF(REGN(3) .EQ. 0.0) GO TO 340
      K = REGN(3)
      KK = K + 1
      TMPY = CYCNW(1) + CYCNW(2) + 1.0
      DO 330 I=1,LAND
      IF(TRET(I) .LT. TMPY) GO TO 330
      ADD = 0.0
      VBHV = 0.0
      VCHV = 0.0
      VLBF2 = 0.0
      VLCU2 = 0.0
      M = AGEOS(I)
      VLBF2 = ANBDF(KK)
      VLCU2 = ANCUV(KK)
C
C COMPUTE BD. FT. FROM THIRD CUTS.
C
      IF(VLBF2 .LT. COMBF) GO TO 310
      VLBF = VLBF + VLBF2
      VBHV = VLBF2
      RETHV = RETHV + VBHV * PRIBD(IYRM)
C
C CU. FT. NOT IN SAWLOGS INCLUDED IN CU. FT. CUT, IF COMMERCIAL.
C
      IF(M .GT. K) M = K
      IF(M .EQ. 0) GO TO 320
      IF(DIAM(M) .EQ. 0.0) GO TO 320
      GO TO (270,275,280), NSP
  270 ADD = VLBF2 * (61.79999 + 2677.97761 / DIAM(M) - 4.03445 * VLBF2)
      GO TO 300
  275 ADD = VLBF2 * (209.34226 + 298.06217 / DIAM(M) - 0.54225 * VLBF2)
      GO TO 300
  280 CONTINUE
  300 TEM = VLCU2
      VCHV = TEM - ADD
      IF(VCHV .LT. EXTCU) GO TO 320
      VLCU = VLCU + VCHV
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
      GO TO 320
C
C COMPUTE CU. FT. IF BD. FT. VOLUME NOT COMMERCIAL.
C
  310 IF(VLCU2 .LT. COMCU) GO TO 330
      VLCU = VLCU + VLCU2
      VCHV = VLCU2
      RETHV = RETHV + VCHV * 0.01 * PRICF(IYRM)
C
C CHANGE STAND AGE AND STORY DESIGNATION TO MATCH CUT.
C
  320 TRET(I) = 0.0
      AGEOS(I) = AGEUN(I)
      AGEUN(I) = 0.0
  330 CONTINUE
  340 IF(KAI .LT. IALCUT) IALCUT = KAI
      IF(MIX .GE. INT) GO TO 350
      RETURN
  350 CALL ARNG
      RETURN
      END
```

Subroutine ARNG

```
      SUBROUTINE ARNG
C
C TO REARRANGE ACRES FOR SIMULATION PERIODS LONGER THAN REGENERATION
C PERIOD.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKDLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STANO,VDM,
     2YSOM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,OEFDR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLDS
      COMMON AGEDS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      DO 5 I=1,180
    5 NACOS(I) = 0
C
C PRESERVE VALUES OF TRET(I) GREATER THAN ZERO.
C
      KU = 0
      LAB = 0
      DO 10 I=1,LAND
      LAB = I - 1
      IF(TRET(I) .GT. 0.0) GO TO 15
   10 CONTINUE
   15 DO 20 I=1,LAND
      KU = KU + 1
      KDX = LAB + I
      IF(KDX .GT. LAND) GO TO 25
      TRET(I) = TRET(KDX)
   20 CONTINUE
   25 DO 30 I=KU,LAND
   30 TRET(I) = 0.0
C
C SUM ACRES BY 1-YEAR AGE CLASSES.
C
      DO 40 I=1,LAND
      LM = AGEOS(I) + 1.0
      NACOS(LM) = NACOS(LM) + 1
   40 CONTINUE
      DO 50 I=1,LAND
      AGEOS(I) = 0.0
      AGEUN(I) = 0.0
   50 CONTINUE
C
C CONVERT OVERSTORY ACRES IN EACH NACOS(I) TO INDIVIDUAL ACRES.
C ASSIGN UNDERSTORY ACRES TO APPROPRIATE OVERSTORY.
C
      JK = 0
      DO 70 J=1,180
      IF(JK .GT. LAND) GO TO 80
      IF(NACOS(J) .LE. 0) GO TO 70
      KL = JK + 1
      JK = JK + NACOS(J)
      DO 60 I=KL,JK
      NAC = LAND + 1 - I
      AGEOS(NAC) = J - 1
      IF(TRET(NAC) .LE. 1.0) GO TO 60
      AGEUN(NAC) = TRET(NAC) - 1.0
   60 CONTINUE
   70 CONTINUE
C
C COMPUTE INDEX TO LOCATE NEXT ACRE FOR INITIAL HARVEST.
C
   80 LAST = 0
      DO 90 I=1,LAND
      IF(TRET(I) .EQ. 0.0) GO TO 100
      LAST = LAST + 1
   90 CONTINUE
  100 RETURN
      END
```

Subroutine SUMS

```
      SUBROUTINE SUMS
C
C TO SUMMARIZE RESULTS OF ANNUAL CHANGES.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKDLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VDM,
     2YSOM(180)
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```
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C COMPUTE GROWING STOCK VOLUME. USE CU. FT. IF VOLUME IS LESS THAN
C BFMRCH BOARD FEET.
C
      DO 50 MU=1,2
      AMU = MU
      IF(AMU .EQ. 2.0 .AND. REGN(2) .EQ. 0.0) GO TO 60
      DO 40 I=1,LAND
      IF(AMU .EQ. 2.0) GO TO 5
      IF(AGEOS(I) .LT. AGMRCH) GO TO 40
      IAG = AGEOS(I) + 1.0
      IF(REGN(2) .EQ. 0.0) GO TO 10
      IF(AGEOS(I) .LE. REGN(1)) GO TO 10
      TEM = AGEOS(I) - REGN(1) + 1.0
      IF(TRET(I) .LT. TEM) IAG = IAG - (TEM - TRET(I))
      GO TO 10
    5 IF(AGEUN(I) .LT. AGMRCH) GO TO 40
      IAG = AGEUN(I) + 1.0
   10 IBG = IAG - 1
      IF(TRET(I) .GT. 0.0) GO TO 15
      IF(IBG .LT. MTHN) GO TO 15
      GBL1 = ANBDF(IAG) + BDFC(IBG)
      IF(GBL1 .LT. BFMRCH) GO TO 20
      GVLBF = GVLBF + GBL1
      GO TO 40
   15 GBL1 = ANBDF(IAG)
      IF(GBL1 .LT. BFMRCH) GO TO 20
      GVLBF = GVLBF + GBL1
      GO TO 40
   20 IF(IBG .LT. MTHN) GO TO 30
      GCL1 = ANCUV(IAG) + CFMC(IBG)
      GVLCU = GVLCU + GCL1
      GO TO 40
   30 GCL1 = ANCUV(IAG)
      GVLCU = GVLCU + GCL1
   40 CONTINUE
   50 CONTINUE
C
C PREPARE FOR NEW TOTALS AND SUBTOTALS.
C
   60 DO 70 K=1,180
      NACOS(K) = 0
   70 NACUN(K) = 0
      DO 80 I=1,18
      ISUM(I) = 0
   80 NSUM(I) = 0
      DO 90 K=1,LAND
      LM = AGEOS(K) + 1.0
      NACOS(LM) = NACOS(LM) + 1
      ML = AGEUN(K) + 1.0
      NACUN(ML) = NACUN(ML) + 1
   90 CONTINUE
C
C COMPUTE TOTAL ACREAGE BY 10-YEAR AGE CLASSES.
C
      DO 100 I=1,18
      DO 100 J=1,10
      NS = 10 * (I - 1) + J
      ISUM(I) = ISUM(I) + NACOS(NS)
      NSUM(I) = NSUM(I) + NACUN(NS)
  100 CONTINUE
C
C COMPUTE VOLUMES AND VALUES AT END OF CURRENT YEAR FOR USE BY ANUAL.
C
      RETRN = RETTH + RETHV
      CSTAC = LAND * ACCST + SCPLT + SCTHN + SCLOSS
      CSTVL = CUCST * (VLCU * 0.01) + BFCST * VLBF
      TCOST = CSTAC + CSTVL
      ANNET = RETRN - TCOST
      GSVALB = GVLBF * (PRIBD(IYRM) - BFCST)
      GSVALC = (GVLCU * 0.01) * (PRICF(IYRM) - CUCST)
C
C INCREASE COSTS ANNUALLY, IF DESIRED.
C
      ACCST = ACCST + (ACCST * RATE)
      BFCST = BFCST + (BFCST * RATE)
      CLOSS = CLOSS + (CLOSS * RATE)
      CPLT = CPLT + (CPLT * RATE)
      CTHN = CTHN + (CTHN * RATE)
      CUCST = CUCST + (CUCST * RATE)
      RETURN
      END
```

Subroutine ANUAL

```
      SUBROUTINE ANUAL
C
C TO STORE ANNUAL VALUES FOR PRINTING LATER.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),OLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLO
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C CONVERT VOLUMES AND AREAS TO SUBSCRIPTED VALUES FOR FUTURE USE.
C
      K = IYEAR
      J = IYEAR + 1
      IVAR(1,J) = IALCUT
      IVAR(2,J) = CUTAGE
      IVAR(3,J) = VLCU + 0.5
      IBFT = VLBF + 0.5
      IVAR(4,J) = IVAR(4,J) + IBFT
      IVAR(5,J) = IVAR(5,K) + IVAR(3,J)
      IVAR(6,J) = IVAR(6,K) + IVAR(4,J)
      IVAR(7,J) = GVLCU + 0.5
      IVAR(8,J) = GVLBF + 0.5
      IVAR(9,J) = IVAR(5,J) + IVAR(7,J)
      IVAR(10,J) = IVAR(6,J) + IVAR(8,J)
      IVAR(11,J) = NONSTK
      DO 1 I=1,14
      N = I + 11
      JVAR(I,J) = NSUM(I)
    1 IVAR(N,J) = ISUM(I)
      DO 5 I=15,18
      JVAR(15,J) = JVAR(15,J) + NSUM(I)
    5 IVAR(26,J) = IVAR(26,J) + ISUM(I)
C
C STORE MONEY VALUES IN ARRAYS FOR REMAINING ROUTINES.
C
      VAR(1,J) = PRICF(J)
      VAR(2,J) = PRIBD(J)
      VAR(3,J) = VAR(3,J) + RETRN
      VAR(4,J) = VAR(4,K) + VAR(3,J)
      VAR(5,J) = CSTAC
      VAR(6,J) = VAR(6,K) + VAR(5,J)
      VAR(7,J) = VAR(7,J) + CSTVL
      VAR(8,J) = VAR(8,K) + VAR(7,J)
      VAR(9,J) = VAR(5,J) + VAR(7,J)
      VAR(10,J) = VAR(10,K) + VAR(9,J)
      VAR(11,J) = VAR(3,J) - VAR(9,J)
      VAR(12,J) = VAR(12,K) + VAR(11,J)
      VAR(13,J) = GSVALC + GSVALB
      VAR(14,J) = VAR(12,J) + VAR(13,J)
      RETURN
      END
```

Subroutine REPRT2

```
      SUBROUTINE REPRT2
C
C TO REPORT VALUES COMPUTED EACH YEAR OF THE SIMULATION.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPC
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),OLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,ROTA,STAND,VDM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHD(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
      N = NOYRS + 1
      DO 180 MAC=1,5
      IF(MAC .EQ. 3 .AND. REGN(2) .EQ. 0.0) GO TO 180
      M = 40
      DO 175 J=1,N
      LINE = J - 1
      IF(M .LT. 40) GO TO 110
      M = 0
      WRITE (6,1)
    1 FORMAT (1H1,//,48X,11HPAGE TYPE 5)
      WRITE (6,2)
    2 FORMAT (1H0,35X,36HSTATUS OF FOREST AT END OF EACH YEAR)
      WRITE (6,5) (BATCH(I),I=1,3)
    5 FORMAT (1H ,45X,7HBATCH  ,3A8)
      WRITE (6,10) ITEST
   10 FORMAT (1H ,45X,4HTEST,I4)
      WRITE (6,15) (GMNAM(I),I=1,3)
   15 FORMAT (1H ,45X,6HGAME  ,3A8)
      WRITE (6,20) (DESCR(I),I=1,5)
   20 FORMAT (1H ,45X,5A8)
      WRITE (6,25)
   25 FORMAT (1H )
      GO TO (30,50,67,70,90), MAC
C
C PRINT FIRST PAGE OF ANNUAL RESULTS ON PAGE TYPE 5.
C
   30 WRITE (6,35)
```

```
   35 FORMAT (1H ,12X,9HALLOWABLE,5X,7HCUTTING,8X,10HACTUAL CUT,10X,9HCU
     1MUL CUT,10X,9HGRSTK VOL,12X,9HTOTAL VOL)
      WRITE (6,40)
   40 FORMAT (1H ,2X,4HYEAR,9X,3HCUT,10X,3HAGE,7X,6HCU.FT.,5X,3HM8F,6X,6
     1HCU.FT.,5X,3HM8F,6X,6HCU.FT.,5X,3HMBF,6X,6HCU.FT.,5X,3HMBF)
      WRITE (6,45)
   45 FORMAT (1H ,15X,3H(1),10X,3H(2),8X,3H(3),7X,3H(4),7X,3H(5),7X,3H(6
     1),7X,3H(7),7X,3H(8),7X,3H(9),6X,4H(10),//)
      GO TO 110
C
C PRINT SECONO PAGE OF ANNUAL RESULTS OF PAGE TYPE 5.
C
   50 WRITE (6,55)
   55 FORMAT (1H ,11X,3HNON,41X,22HAGE CLASSES, OVERSTORY)
      WRITE (6,60)
   60 FORMAT (1H ,2X,4HYEAR,5X,3HSTK,114H   0-9  10-19  20-29  30-39  40
     1-49  50-59  60-69  70-79  80-89  90-99  100-109  110-119  120-129
     2 130-139  140-179)
      WRITE (6,65)
   65 FORMAT (1H ,10X,117H(11)    (12)  (13)    (14)   (15)   (16)   (17)
     1  (18)   (19)   (20)   (21)    (22)     (23)      (24)      (25)
     2 (26),//)
      GO TO 110
C
C PRINT THIRO PAGE OF ANNUAL RESULTS OF PAGE TYPE 5.
C
   67 WRITE (6,68)
   68 FORMAT(1H ,11x,3HNON,40X,23HAGE CLASSES, UNOERSTORY)
      WRITE (6,60)
      WRITE (6,65)
      GO TO 110
C
C PRINT FOURTH PAGE OF ANNUAL RESULTS OF PAGE TYPE 5.
C
   70 WRITE (6,75)
   75 FORMAT (1H ,18X,14HSTUMPAGE PRICE,9X,15HSTUMPAGE INCOME,13X,10HARE
     1A COSTS,15X,12HVOLUME COSTS)
      WRITE (6,80)
   80 FORMAT (1H ,2X,4HYEAR,9X,10H100 CU.FT.,5X,3HMBF,6X,6HANNUAL,5X,9HC
     1UMULATEO,6X,6HANNUAL,5X,9HCUMULATED,6X,6HANNUAL,5X,9HCUMULATEO)
      WRITE (6,85)
   85 FORMAT (1H ,18X,4H(27),8X,4H(28),6X,4H(29),9X,4H(30),9X,4H(31),9X,
     14H(32),9X,4H(33),9X,4H(34),//)
      GO TO 110
C
C PRINT FIFTH PAGE OF ANNUAL RESULTS OF PAGE TYPE 5.
C
   90 WRITE (6,95)
   95 FORMAT (1H ,18X,10HTOTAL COST,17X,10HNET INCOME,13X,13HCURRENT VAL
     1UE,9X,5HTOTAL)
      WRITE (6,100)
  100 FORMAT (1H ,2X,4HYEAR,8X,6HANNUAL,5X,9HCUMULATEO,7X,6HANNUAL,5X,9H
     1CUMULATEO,7X,13HGROWING STOCK,7X,9HNET WORTH)
      WRITE (6,105)
  105 FORMAT (1H ,15X,4H(35),9X,4H(36),10X,4H(37),9X,4H(38),13X,4H(39),1
     14X,4H(40),//)
C
C WRITE BOOY OF EACH TABLE.
C
  110 GO TO (115,125,133,135,145), MAC
  115 WRITE (6,120) LINE,(IVAR(I,J),I=1,10)
  120 FORMAT (1H ,I6,I12,I13,I12,I9,3(I11,I9))
      GO TO 160
  125 WRITE (6,130) LINE,(IVAR(I,J),I=11,26)
  130 FORMAT (1H ,I6,2I7,I6,8I7,I8,4I9)
      GO TO 160
  133 WRITE (6,130) LINE,IVAR(11,J),(JVAR(I,J),I=1,15)
      GO TO 160
  135 WRITE (6,140) LINE,(VAR(I,J),I=1,8)
  140 FORMAT (1H ,I6,F16.2,F11.2,F12.0,F11.0,2(F15.0,F11.0))
      GO TO 160
  145 WRITE (6,150) LINE,(VAR(I,J),I=9,14)
  150 FORMAT (1H ,I6,F14.0,F12.0,F15.0,F12.0,2F18.0)
  160 IF(J .LE. 1) GO TO 165
      M = M + 1
      IF(LL .LT. 10) GO TO 170
  165 WRITE (6,25)
      LL = 0
  170 LL = LL + 1
  175 CONTINUE
  180 CONTINUE
      RETURN
      ENO
```

Subroutine WORTH

```
      SU8ROUTINE WORTH
C
C TO COMPUTE PRESENT VALUES ANO RATES EARNEO.
C CONTAINS NO STATEMENTS TO BE MOOIFIED TO AOAPT TO OTHER SPECIES.
C
      COMMON 8ATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,AN8OF(181),ANCUV(181),8FMRCH,8FPCT,8FSALV,CFPCT
     1,COM8F,COMCU,CYCL,CYCNW(3),O8HO,OENO,OESCR(5),OLEV,GIOE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRI8O(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BOFC(180),8OFO(180),CFMC(180),CFMO(180),CUFT,OBHT,
     1OIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROO,REST,ROTA,STAND,VOM,
     2YSOM(180)
      COMMON ACCST,ANUL,8FCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,OEFOR,
     1FMRCHO(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLO,NACOS(180),
     3NACUN(180),NONSTK,PRIDV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVAL8,GSVALC,GVL8F,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),V8HV,VCHV,VL8F,VLCU
C
      DIMENSION CRATE(20),DISC(20),OISG(20),DISI(20),PREV(20),PWTH(20),R
     1ATIO(20,150)
C
      DO 1 I=1,20
      CRATE(I) = 0.0
      OISC(I) = 0.0
      DISG(I) = 0.0
      DISI(I) = 0.0
      PREV(I) = 0.0
    1 PWTH(I) = 0.0
      DO 5 I=1,20
      DO 5 J=1,150
    5 RATIO(I,J) = 0.0
C
C COMPUTE A SERIES OF ALTERNATIVE RATES.
C
      CRATE(1) = 0.010
      DO 10 I=1,19
      K = I + 1
   10 CRATE(K) = CRATE(I) + 0.005
C
C COMPUTE AN INTEREST TABLE FOR THE PERIOD NOYRS.
C
      OO 15 J=1,20
      FACTR = 1.0 + CRATE(J)
      OO 15 K=1,NOYRS
      YRS = K
      PRPN = ALOG(FACTR) * YRS
      RATIO(J,K) = EXP(PRPN)
   15 CONTINUE
C
C DISCOUNT GROWING STOCK VALUE AT NOYRS.
C
      DO 20 L=1,20
      KL = NOYRS + 1
      DISG(L) = VAR(13,KL) / RATIO(L,NOYRS)
   20 CONTINUE
C
C DISCOUNT ANNUAL COSTS ANO RETURNS.
C
      OO 30 M=1,20
      PRESC = 0.0
      PRESI = 0.0
      SPRSC = 0.0
      SPRSI = 0.0
      DO 25 N=1,NOYRS
      I = N + 1
      PRESC = VAR(9,I) / RATIO(M,N)
      PRESI = VAR(3,I) / RATIO(M,N)
      SPRSC = SPRSC + PRESC
      SPRSI = SPRSI + PRESI
   25 CONTINUE
      OISI(M) = SPRSI
      DISC(M) = SPRSC
   30 CONTINUE
C
C COMPUTE PRESENT WORTH AT EACH RATE.
C
      OO 35 IJ=1,20
      PREV(IJ) = OISI(IJ) + OISG(IJ)
      PWTH(IJ) = PREV(IJ) - OISC(IJ) - VAR(13,1)
      CRATE(IJ) = CRATE(IJ) * 100.0
   35 CONTINUE
C
C SUMMARIZE COMPUTATIONS ON PAGE TYPE 6.
C
      WRITE (6,40)
   40 FORMAT (1H1,//,62X,11HPAGE TYPE 6/1HO,52X,29HPRESENT WORTH ANO RAT
     1E EARNEO)
      WRITE (6,45) (BATCH(I),I=1,3)
   45 FORMAT (1H ,52X,7H8ATCH  ,3A8)
      WRITE (6,50) ITEST
   50 FORMAT (1H ,52X,4HTEST,I4)
      WRITE (6,55) (GMNAM(I),I=1,3)
   55 FORMAT (1H ,52X,6HGAME  ,3A8)
      WRITE (6,60) (OESCR(I),I=1,5)
   60 FORMAT (1H ,52X,5A8)
      WRITE (6,65) NOYRS
   65 FORMAT (1H ,52X,15HYEARS IN PERIOO,I5,//)
      WRITE (6,75) VAR(13,1)
   75 FORMAT (1H ,11X,33HVALUE OF INITIAL GROWING STOCK--$,F10.2,//)
      WRITE (6,80)
   80 FORMAT (1H ,57X,38HVALUES OISCOUNTEO TO PRESENT (OOLLARS),/)
      WRITE (6,90)
   90 FORMAT (1H ,11X,8HCOMPOUNO,14X,6HFUTURE,34X,5HSTOCK,36X,3HNET)
      WRITE (6,100)
  100 FORMAT (1H ,13X,4HRATE,15X,7HGROWING,15X,3HALL,17X,4HPLUS,16X,3HAL
     1L,15X,7HPRESENT)
      WRITE (6,110)
  110 FORMAT (1H ,11X,9H(PERCENT),13X,5HSTOCK,14X,7HINCOMES,13X,7HINCOME
     1S,14X,5HCOSTS,15X,5HWORTH,/)
      DO 130 I=1,20
      WRITE (6,120) CRATE(I),OISG(I),OISI(I),PREV(I),OISC(I),PWTH(I)
  120 FORMAT (1H ,12X,F5.1,12X,5(F10.2,10X),/)
  130 CONTINUE
      RETURN
      END
```

Subroutine SUMRY

```
      SUBROUTINE SUMRY
C
C TO PRINT SPECIFIED COLUMNS OF PAGE TYPE 5 AS SUMMARY OF RESULTS.
C CONTAINS NO STATEMENTS TO BE MODIFIED TO ADAPT TO OTHER SPECIES.
C
      COMMON BATCH(3),FLAG1,FLAG2,IGAME,ITEST,IYEAR
      COMMON AGEO,AGMRCH,ANBDF(181),ANCUV(181),BFMRCH,BFPCT,BFSALV,CFPCT
     1,COMBF,COMCU,CYCL,CYCNW(3),DBHO,DENO,DESCR(5),DLEV,GIDE,GNTR,
     2KOL(6),NGAME,NKOLS,NOYRS,NSP,PRIBD(150),PRICF(150),REGN(3),RINT,
     3SITE,SPEC(5),SUMM(6,25,10),THIN,VLLV(3),EXTCU
      COMMON BA,BAST,BDFC(180),BDFO(180),CFMC(180),CFMO(180),CUFT,DBHT,
     1DIAM(180),FCTR,HITE,JCYCL,NAGO,PRET,PROD,REST,RDTA,STAND,VOM,
     2YSDM(180)
      COMMON ACCST,ANUL,BFCST,CLOSS,CPLT,CSTAC,CSTVL,CTHN,CUCST,DEFOR,
     1FMRCHO(10),GMNAM(3),IACRE(180),IALCUT,IPLNT,IVAR(26,150),
     2JVAR(15,150),KOUNT,LAND,LAST,MALCUT(10),MOLD,NACOS(180),
     3NACUN(180),NONSTK,PRIDIV(10),RATE,RETRN,VAR(14,150),YRLOS
      COMMON AGEOS(1000),AGEUN(1000),ANNET,CUTAGE,GSVALB,GSVALC,GVLBF,
     1GVLCU,ISUM(18),IYRM,KACR,LOSS,MIX,MTHN,NSUM(18),RETHV,RETTH,SCLOSS
     2,SCPLT,SCTHN,TCOST,TRET(1000),VBHV,VCHV,VLBF,VLCU
C
C CONVERT IVAR(I,J) AND VAR(I,J) TO SUMM(I,J,K) AT END OF EACH GAME.
C
      LIM = 10 + NOYRS / 10
      DO 20 I=1,NKOLS
      DO 20 J=1,LIM
      K = KOL(I)
      IF(J .GT. 10) GO TO 5
      JJ = J + 1
      GO TO 10
    5 JJ = 10 * (J - 10) + 1
   10 IF(K .GT. 26) GO TO 15
      SUMM(I,J,IGAME) = IVAR(K,JJ)
      GO TO 20
   15 K = K - 26
      SUMM(I,J,IGAME) = VAR(K,JJ)
   20 CONTINUE
C
C WRITE SUMMARY TABLES ON PAGE TYPE 7 WHEN ALL GAMES ARE FINISHED.
C
      IF(IGAME .LT. NGAME) GO TO 150
C
C WRITE PAGE HEADINGS WITH SEPARATE PAGE FOR EACH COLUMN OF REPRT2
C IDENTIFIED IN BASIS1.
C
      DO 120 I=1,NKOLS
      WRITE (6,30)
   30 FORMAT (1H1,//,54X,11HPAGE TYPE 7/1H0,45X,26HCOMPARISON OF ALTERNA
     1TIVES)
      WRITE (6,35) (BATCH(N),N=1,3)
   35 FORMAT (1H ,45X,7HBATCH  ,3A8)
      WRITE (6,40) ITEST
   40 FORMAT (1H ,45X,4HTEST,I4)
      WRITE (6,45) (DESCR(N),N=1,5)
   45 FORMAT (1H ,45X,5A8)
      K = KOL(I)
      WRITE (6,50) K
   50 FORMAT (1H ,45X,8HCOLUMN  ,I3,///)
      WRITE (6,60)
   60 FORMAT (1H ,5X,4HYEAR,6X,6HGAME 1,6X,6HGAME 2,6X,6HGAME 3,6X,6HGAM
     1E 4,6X,6HGAME 5,6X,6HGAME 6,6X,6HGAME 7,6X,6HGAME 8,6X,6HGAME 9,6X
     2,7HGAME 10,//)
      M = 0
C
C WRITE SUMM(I,J,K) FOR EACH OF FIRST 10 YEARS AND FOR END EACH DECADE.
C
      DO 120 J=1,25
      IF(J .GT. 10) GO TO 70
      JJ = J
      GO TO 80
   70 JJ = 10 * (J - 10)
   80 IF(M .LT. 5) GO TO 100
      WRITE (6,90)
   90 FORMAT (1H ,//)
      M = 0
  100 WRITE (6,110) JJ,(SUMM(I,J,L),L=1,10)
  110 FORMAT (1H ,I9,F11.0,9F12.0)
  120 M = M + 1
  150 RETURN
      END
```

Appendix 2: Output of MANGD2

PAGF TYPE 1

YIELOS PER ACRE OF MANAGEO, EVEN-AGED STANOS OF BLACK HILLS PONDEROSA PINE

SITE INOEX 70, 20-YEAR CUTTING CYCLE

THINNING LEVELS= INITIAL - 120., SUBSEQUENT - 100.

	ENTIRE STANO BEFORE ANO AFTER THINNING							PERIOOIC INTERMEOIATE CUTS				
STANO AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE O.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME MBF	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME MBF
30.	950	119	4.8	25	1188	309.	0.000					
30.	463	79	5.6	26	849	309.	0.000	487	40	339	0.	0.000
40.	458	109	6.6	35	1559	981.	0.000					
50.	449	134	7.4	44	2408	1848.	.900					
50.	251	92	8.2	45	1701	1443.	.900	198	42	707	405.	0.000
60.	249	115	9.2	51	2420	2192.	3.760					
70.	246	134	10.0	58	3200	2964.	7.630					
70.	160	100	10.7	59	2456	2294.	6.810	86	34	744	670.	.820
80.	160	117	11.6	64	3230	3033.	11.880					
90.	160	134	12.4	69	4017	3786.	15.120					
90.	105	100	13.2	70	3030	2867.	12.010	55	34	987	919.	3.110
100.	105	115	14.2	74	3747	3558.	16.080					
110.	105	131	15.1	78	4468	4255.	20.410					
110.	32	49	16.8	80	1734	1659.	8.400	73	82	2734	2596.	12.010
120.	32	58	18.3	83	2148	2063.	11.170					
130.	32	68	19.7	86	2581	2485.	14.210					
130.	10	25	21.3	87	964	931.	5.530	22	43	1617	1554.	8.680
140.	10	30	23.3	90	1189	1151.	7.260					

THIS TABLE SHOWS VALUES FOR SEEO TREE OR SHELTERWOOO CUTTING WITH TIMING ANO AMOUNTS SPECIFIEO PREVIOUSLY.

MERCH. CU. FT. - TREES 6.0 INCHES O.B.H. ANO LARGER TO 4-INCH TOP.

BO. FT. - TREES 10.0 INCHES O.B.H. ANO LARGER TO 8-INCH TOP.

PAGE TYPE 2

GROWING STOCK OF MANAGEO BLACK HILLS PONDEROSA PINE
SITE INOEX 70., 20.-YEAR CUTTING CYCLE
OENSITY LEVEL- 120. AND 100.

VOLUMES PRESENT PER ACRE AT END OF EACH YEAR
MERCHANTABLE CUBIC FEET

	YEAR									
OECAOE	0	1	2	3	4	5	6	7	8	9
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	309.0	376.2	443.4	510.6	577.8	645.0	712.2	779.4	846.6	913.8
4	981.0	1067.7	1154.4	1241.1	1327.8	1414.5	1501.2	1587.9	1674.6	1761.3
5	1443.0	1517.9	1592.8	1667.7	1742.6	1817.5	1892.4	1967.3	2042.2	2117.1
6	2192.0	2269.2	2346.4	2423.6	2500.8	2578.0	2655.2	2732.4	2809.6	2886.8
7	2294.0	2367.9	2441.8	2515.7	2589.6	2663.5	2737.4	2811.3	2885.2	2959.1
8	3033.0	3108.3	3183.6	3258.9	3334.2	3409.5	3484.8	3560.1	3635.4	3710.7
9	2867.0	2936.1	3005.2	3074.3	3143.4	3212.5	3281.6	3350.7	3419.8	3488.9
10	3558.0	3627.7	3697.4	3767.1	3836.8	3906.5	3976.2	4045.9	4115.6	4185.3
11	1659.0	1699.4	1739.8	1780.2	1820.6	1861.0	1901.4	1941.8	1982.2	2022.6
12	2063.0	2105.2	2147.4	2189.6	2231.8	2274.0	2316.2	2358.4	2400.6	2442.8
13	931.0	953.0	975.0	997.0	1019.0	1041.0	1063.0	1085.0	1107.0	1129.0
14	1151.0									

THOUSANOS OF BOARO FEET

0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	.090	.180	.270	.360	.450	.540	.630	.720	.810
5	.900	1.186	1.472	1.758	2.044	2.330	2.616	2.902	3.188	3.474
6	3.760	4.147	4.534	4.921	5.308	5.695	6.082	6.469	6.856	7.243
7	6.810	7.317	7.824	8.331	8.838	9.345	9.852	10.359	10.866	11.373
8	11.880	12.204	12.528	12.852	13.176	13.500	13.824	14.148	14.472	14.796
9	12.010	12.417	12.824	13.231	13.638	14.045	14.452	14.859	15.266	15.673
10	16.080	16.513	16.946	17.379	17.812	18.245	18.678	19.111	19.544	19.977
11	8.400	8.677	8.954	9.231	9.508	9.785	10.062	10.339	10.616	10.893
12	11.170	11.474	11.778	12.082	12.386	12.690	12.994	13.298	13.602	13.906
13	5.530	5.703	5.876	6.049	6.222	6.395	6.568	6.741	6.914	7.087
14	7.260									

PAGE TYPE 3

ALTERNATIVES FOR THIS GAME
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.

NUMBER OF YEARS PER GAME 30

CRITICAL PRICES	99.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALLOWABLE CUT	8	0	0	0	0	0	0	0	0	0
MINIMUM CUTTING AGE	110.	0.	0.	0.	0.	0.	0.	0.	0.	0.

ACRES IN WORKING CIRCLE	885
MINIMUM VALUES FOR INCLUSION IN TOTALS	
AGE, FOR GROWING STOCK	40.
M BD. FT., FOR GROWING STOCK	1.5
CU. FT., FOR COMMERCIAL CUT	300.
M BD. FT., FOR COMMERCIAL CUT	1.5
M BD. FT., FOR SALVAGE	1.5
CU. FT. IN SAW LOG CUT	100.
ACRES PLANTED ANNUALLY	1
PERCENT OF ACRES LOST ANNUALLY	.040
PSEUDORANDOM NUMBER GENERATOR	21.0
	2222.0

COSTS IN FIRST YEAR OF GAME	
PER ACRE (ANNUAL)	.20
PER 100 CU. FT. HARVESTED	.05
PER M BD. FT.	1.56
THIN ONE ACRE	25.00
PLANT ONE ACRE	30.00
CLEANUP OF ONE ACRE	25.00
RATE OF INCREASE IN COSTS	.01
RELATIVE VALUE OF INTERMEDIATE CUTS	
STUMPAGE PRICE, CU. FT.	1.00
STUMPAGE PRICE, BD. FT.	.85

PAGE TYPE 4

DISTRIBUTION OF OVERSTORY ACRES BY AGE
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.
YEAR WITHIN GAME 0

AGE(DECADE)	AGE(YEAR) 0	1	2	3	4	5	6	7	8	9	TOTAL
0	5	0	0	0	0	0	0	0	0	0	5
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	8	8	8	8	8	8	8	8	8	8	80
4	8	8	8	8	8	8	8	8	8	8	80
5	8	8	8	8	8	8	8	8	8	8	80
6	8	8	8	8	8	8	8	8	8	8	80
7	8	8	8	8	8	8	8	8	8	8	80
8	8	8	8	8	8	8	8	8	8	8	80
9	8	8	8	8	8	8	8	8	8	8	80
10	8	8	8	8	8	8	8	8	8	8	80
11	8	8	8	8	8	8	8	8	8	8	80
12	8	8	8	8	8	8	8	8	8	8	80
13	8	8	8	8	8	8	8	8	8	8	80
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 4

DISTRIBUTION OF UNDERSTORY ACRES BY AGE
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.
YEAR WITHIN GAME 0

	AGE(YEAR)										
AGE(OECADE)	0	1	2	3	4	5	6	7	8	9	TOTAL
0	653	8	8	8	8	8	8	8	8	8	725
1	8	8	8	8	8	8	8	8	8	8	80
2	8	8	8	8	8	8	8	8	8	8	80
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 4

DISTRIBUTION OF OVERSTORY ACRES BY AGE
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.
YEAR WITHIN GAME 30

	AGE(YEAR)										
AGE(OECAOE)	0	1	2	3	4	5	6	7	8	9	TOTAL
0	0	1	0	0	1	0	0	1	0	0	3
1	1	0	0	1	0	1	0	0	1	0	4
2	0	1	0	0	1	1	1	1	1	1	7
3	9	8	8	8	8	8	8	8	8	8	81
4	8	8	8	8	8	8	8	8	8	8	80
5	8	8	8	8	8	8	8	8	8	8	80
6	8	8	8	8	8	8	8	8	8	8	80
7	8	8	8	8	8	8	8	6	8	8	78
8	8	8	8	8	8	8	8	8	8	8	80
9	8	8	7	7	8	8	8	8	8	8	78
10	8	8	8	8	8	8	8	8	7	7	78
11	8	8	8	8	8	8	8	8	8	8	80
12	8	8	8	8	7	7	8	8	8	8	78
13	8	6	8	8	8	8	8	8	8	8	78
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 4

DISTRIBUTION OF UNDERSTORY ACRES BY AGE
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.
YEAR WITHIN GAME 30

AGE(DECADE)	AGE(YEAR) 0	1	2	3	4	5	6	7	8	9	TOTAL
0	664	7	8	8	7	8	8	7	8	8	733
1	7	8	8	7	8	6	8	8	7	8	75
2	8	7	8	8	7	8	8	7	8	8	77
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 5

STATUS OF FOREST AT END OF EACH YEAR
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.

YEAR	ALLOWABLE CUT (1)	CUTTING AGE (2)	ACTUAL CUT CU.FT. (3)	ACTUAL CUT MBF (4)	CUMUL CUT CU.FT. (5)	CUMUL CUT MBF (6)	GRSTK VOL CU.FT. (7)	GRSTK VOL MBF (8)	TOTAL VOL CU.FT. (9)	TOTAL VOL MBF (10)
0	0	0	0	0	0	0	146122	7210	146122	7210
1	8	110	12179	248	12179	248	146122	7210	158301	7458
2	8	110	12179	248	24358	496	146122	7210	170480	7706
3	7	110	11873	254	36231	750	146122	7204	182353	7954
4	8	110	12180	249	48411	999	146122	7204	194533	8203
5	8	110	12180	249	60591	1248	146122	7203	206713	8451
6	7	110	11874	256	72465	1504	146122	7195	218587	8699
7	8	110	12181	249	84646	1753	146122	7194	230768	8947
8	8	110	12181	249	96827	2002	146122	7192	242949	9194
9	7	110	11876	251	108703	2253	146122	7189	254825	9442
10	8	110	12180	249	120883	2502	146122	7187	267005	9689
11	8	110	12180	249	133063	2751	146122	7186	279185	9937
12	7	110	11874	242	144937	2993	146122	7191	291059	10184
13	8	110	12181	249	157118	3242	146122	7189	303240	10431
14	8	110	12181	249	169299	3491	146122	7187	315421	10678
15	7	110	11876	257	181175	3748	146122	7177	327297	10925
16	8	110	12183	249	193358	3997	146122	7175	339480	11172
17	7	110	11876	242	205234	4239	146122	7179	351356	11418
18	8	110	12183	249	217417	4488	146122	7176	363539	11664
19	8	110	12183	249	229600	4737	146122	7173	375722	11910
20	7	110	11877	244	241477	4981	146122	7176	387599	12157
21	8	110	12184	250	253661	5231	146122	7172	399783	12403
22	8	110	12184	250	265845	5481	146122	7169	411967	12650
23	7	110	10397	240	276242	5721	146122	7177	422364	12898
24	8	110	12185	250	288427	5971	146122	7173	434549	13144
25	8	110	12185	250	300612	6221	146122	7168	446734	13389
26	7	110	11738	244	312350	6465	146122	7170	458472	13635
27	8	110	12187	247	324537	6712	146122	7168	470659	13880
28	8	110	12187	247	336724	6959	146122	7167	482846	14126
29	7	110	11739	249	348463	7208	146122	7163	494585	14371
30	8	110	12188	250	360651	7458	146122	7157	506773	14615

PAGE TYPE 5

STATUS OF FOREST AT ENO OF EACH YEAR
BATCH SHELTERWOOO TEST
TEST 1
GAME EOUAL AREAS CUT ANNUALLY
MANAGED, THINNEO AT AGE 30.

YEAR	NON STK (11)	AGE CLASSES, OVERSTORY 0-9 (12)	10-19 (13)	20-29 (14)	30-39 (15)	40-49 (16)	50-59 (17)	60-69 (18)	70-79 (19)	80-89 (20)	90-99 (21)	100-109 (22)	110-119 (23)	120-129 (24)	130-139 (25)	140-179 (26)
0	5	5	0	0	80	80	80	80	80	80	80	80	80	80	80	0
1	4	5	0	0	80	80	80	80	80	80	80	80	80	80	80	0
2	3	5	0	0	80	80	80	80	80	80	80	80	80	80	80	0
3	3	6	0	0	80	80	80	80	80	80	80	79	80	80	80	0
4	2	6	0	0	80	80	80	80	80	80	80	79	80	80	80	0
5	1	6	0	0	80	80	80	80	80	80	80	79	80	80	80	0
6	1	7	0	0	80	80	80	80	80	80	80	78	80	80	80	0
7	0	7	0	0	80	80	80	80	80	80	80	78	80	80	80	0
8	0	7	0	0	80	80	80	80	80	80	80	78	80	80	80	0
9	1	8	0	0	80	80	80	80	80	79	80	80	78	80	80	0
10	0	7	1	0	80	80	80	80	80	79	80	80	78	80	80	0
11	0	6	2	0	80	80	80	80	80	79	80	80	78	80	80	0
12	1	6	3	0	80	80	80	80	79	80	79	80	78	80	80	0
13	0	5	4	0	80	80	80	80	79	80	79	80	78	80	80	0
14	0	4	5	0	80	80	80	80	79	80	79	80	78	80	80	0
15	1	4	6	0	80	80	80	80	79	80	79	79	78	80	80	0
16	0	3	7	0	80	80	80	80	79	80	79	80	77	80	80	0
17	1	4	7	0	80	80	80	79	79	80	79	80	77	80	80	0
18	0	4	7	0	80	80	80	79	80	79	79	80	77	80	80	0
19	0	3	8	0	80	80	80	79	80	79	79	80	79	78	80	0
20	1	4	7	1	80	80	80	78	80	79	79	80	79	78	80	0
21	0	4	6	2	80	80	80	78	80	79	79	80	79	78	80	0
22	0	3	6	3	80	80	80	78	80	79	80	79	79	78	80	0
23	1	4	5	4	80	80	80	80	78	79	80	79	78	78	80	0
24	0	4	4	5	80	80	80	80	78	79	80	79	78	78	80	0
25	0	3	4	6	80	80	80	80	78	79	80	79	79	77	80	0
26	1	4	3	7	80	80	80	80	78	78	80	79	80	76	80	0
27	0	3	4	7	80	80	80	80	78	79	79	79	80	76	80	0
28	0	3	4	7	80	80	80	80	78	80	78	79	80	76	80	0
29	1	4	3	8	80	80	80	80	78	80	78	78	80	78	78	0
30	0	3	4	7	81	80	80	80	78	80	78	78	80	78	78	0

PAGE TYPE 5

STATUS OF FOREST AT ENO OF EACH YEAR
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGEO, THINNED AT AGE 30.

YEAR	NON STK (11)	AGE CLASSES, UNOERSTORY 0-9 (12)	10-19 (13)	20-29 (14)	30-39 (15)	40-49 (16)	50-59 (17)	60-69 (18)	70-79 (19)	80-89 (20)	90-99 (21)	100-109 (22)	110-119 (23)	120-129 (24)	130-139 (25)	140-179 (26)
0	5	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
1	4	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
2	3	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
3	3	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
4	2	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
5	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
6	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
7	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
8	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
9	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
10	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
11	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
12	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
13	0	726	79	80	0	0	0	0	0	0	0	0	0	0	0	0
14	0	726	79	80	0	0	0	0	0	0	0	0	0	0	0	0
15	1	726	79	80	0	0	0	0	0	0	0	0	0	0	0	0
16	0	727	78	80	0	0	0	0	0	0	0	0	0	0	0	0
17	1	727	78	80	0	0	0	0	0	0	0	0	0	0	0	0
18	0	727	78	80	0	0	0	0	0	0	0	0	0	0	0	0
19	0	728	77	80	0	0	0	0	0	0	0	0	0	0	0	0
20	1	728	77	80	0	0	0	0	0	0	0	0	0	0	0	0
21	0	728	77	80	0	0	0	0	0	0	0	0	0	0	0	0
22	0	729	76	80	0	0	0	0	0	0	0	0	0	0	0	0
23	1	729	77	79	0	0	0	0	0	0	0	0	0	0	0	0
24	0	729	77	79	0	0	0	0	0	0	0	0	0	0	0	0
25	0	731	75	79	0	0	0	0	0	0	0	0	0	0	0	0
26	1	731	76	78	0	0	0	0	0	0	0	0	0	0	0	0
27	0	732	75	78	0	0	0	0	0	0	0	0	0	0	0	0
28	0	732	75	78	0	0	0	0	0	0	0	0	0	0	0	0
29	1	732	76	77	0	0	0	0	0	0	0	0	0	0	0	0
30	0	733	75	77	0	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 5

STATUS OF FOREST AT ENO OF EACH YEAR
BATCH SHELTERWOOO TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNEO AT AGE 30.

YEAR	STUMPAGE PRICE 100 CU.FT. (27)	STUMPAGE PRICE MBF (28)	STUMPAGE INCOME ANNUAL (29)	STUMPAGE INCOME CUMULATEO (30)	AREA COSTS ANNUAL (31)	AREA COSTS CUMULATEO (32)	VOLUME COSTS ANNUAL (33)	VOLUME COSTS CUMULATED (34)
0	2.50	14.50	0.	0.	0.	0.	0.	0.
1	2.50	15.20	4025.	4025.	407.	407.	394.	394.
2	2.50	17.80	4661.	8686.	411.	818.	398.	791.
3	2.50	16.80	4461.	13147.	415.	1233.	411.	1202.
4	2.50	13.40	3588.	16735.	419.	1653.	406.	1608.
5	2.50	14.10	3759.	20494.	424.	2076.	410.	2018.
6	2.50	17.40	4634.	25128.	428.	2504.	426.	2444.
7	2.50	11.80	3199.	28327.	432.	2936.	419.	2863.
8	2.50	11.10	3027.	31354.	404.	3340.	423.	3286.
9	2.50	12.20	3290.	34644.	408.	3748.	431.	3717.
10	2.50	12.90	3465.	38110.	445.	4193.	431.	4148.
11	2.50	10.10	2779.	40889.	416.	4610.	435.	4583.
12	2.50	8.30	2271.	43160.	421.	5031.	429.	5012.
13	2.50	9.00	2512.	45672.	459.	5489.	445.	5456.
14	2.50	10.90	2978.	48651.	429.	5918.	449.	5906.
15	2.50	13.90	3776.	52426.	433.	6352.	468.	6373.
16	2.50	13.10	3522.	55948.	473.	6824.	459.	6832.
17	2.50	11.90	3127.	59075.	442.	7266.	450.	7282.
18	2.50	12.70	3423.	62498.	482.	7748.	468.	7750.
19	2.50	15.70	4160.	66658.	451.	8199.	472.	8222.
20	2.50	13.60	3548.	70207.	455.	8655.	467.	8689.
21	2.50	12.10	3279.	73486.	497.	9151.	483.	9171.
22	2.50	15.20	4042.	77528.	465.	9616.	487.	9659.
23	2.50	16.10	4030.	81558.	469.	10085.	472.	10130.
24	2.50	16.70	4415.	85973.	512.	10597.	498.	10628.
25	2.50	19.60	5129.	91102.	479.	11075.	503.	11131.
26	2.50	18.50	4697.	95799.	483.	11559.	496.	11626.
27	2.50	14.70	3888.	99687.	527.	12086.	507.	12133.
28	2.50	15.50	4083.	103770.	493.	12579.	512.	12645.
29	2.50	17.10	4437.	108207.	498.	13077.	521.	13166.
30	2.50	13.00	3512.	111719.	577.	13654.	529.	13696.

PAGE TYPE 5

STATUS OF FOREST AT END OF EACH YEAR
BATCH SHELTERWOOO TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNEO AT AGE 30.

YEAR	TOTAL COST ANNUAL (35)	TOTAL COST CUMULATEO (36)	NET INCOME ANNUAL (37)	NET INCOME CUMULATEO (38)	CURRENT VALUE GROWING STOCK (39)	TOTAL NET WORTH (40)
0	0.	0.	0.	0.	96878.	96878.
1	801.	801.	3224.	3224.	101925.	105149.
2	809.	1609.	3852.	7076.	120557.	127634.
3	826.	2435.	3635.	10711.	113145.	123856.
4	825.	3261.	2762.	13474.	88527.	102001.
5	834.	4094.	2926.	16400.	93444.	109843.
6	853.	4948.	3780.	20180.	116972.	137152.
7	851.	5799.	2348.	22528.	76547.	99075.
8	827.	6626.	2200.	24728.	71378.	96107.
9	839.	7465.	2451.	27179.	79131.	106310.
10	876.	8341.	2589.	29768.	84028.	113796.
11	852.	9193.	1927.	31696.	63770.	95466.
12	849.	10042.	1422.	33118.	50744.	83862.
13	903.	10946.	1609.	34727.	55637.	90364.
14	878.	11824.	2100.	36827.	69151.	105978.
15	901.	12725.	2875.	39702.	90464.	130165.
16	931.	13656.	2591.	42292.	84561.	126853.
17	892.	14548.	2234.	44527.	75865.	120391.
18	950.	15498.	2474.	47000.	81443.	128443.
19	923.	16421.	3237.	50237.	102798.	153035.
20	922.	17343.	2626.	52863.	87631.	140494.
21	979.	18323.	2300.	55163.	76695.	131859.
22	952.	19275.	3090.	58253.	98745.	156998.
23	941.	20215.	3090.	61343.	105173.	166516.
24	1009.	21225.	3406.	64748.	109277.	174025.
25	981.	22206.	4147.	68896.	129861.	198757.
26	979.	23185.	3718.	72614.	121859.	194473.
27	1034.	24219.	2854.	75467.	94448.	169915.
28	1005.	25225.	3078.	78545.	100013.	178558.
29	1019.	26244.	3418.	81963.	111275.	193238.
30	1106.	27350.	2406.	84369.	81699.	166068.

PAGE TYPE 6

PRESENT WORTH AND RATE EARNED
BATCH SHELTERWOOD TEST
TEST 1
GAME EQUAL AREAS CUT ANNUALLY
MANAGED, THINNED AT AGE 30.
YEARS IN PERIOD 30

VALUE OF INITIAL GROWING STOCK--$ 96877.59

VALUES DISCOUNTED TO PRESENT (DOLLARS)

COMPOUND RATE (PERCENT)	FUTURE GROWING STOCK	ALL INCOMES	STOCK PLUS INCOMES	ALL COSTS	NET PRESENT WORTH
1.0	60614.17	95822.44	156436.61	23367.41	36191.62
1.5	52267.79	89061.09	141328.88	21671.91	22779.39
2.0	45103.50	82970.09	128073.59	20143.59	11052.40
2.5	38949.28	77472.88	116422.16	18763.50	781.07
3.0	33658.80	72502.45	106161.26	17515.01	-8231.34
3.5	29107.50	68000.03	97107.53	16383.54	-16153.59
4.0	25189.25	63914.01	89103.26	15356.29	-23130.61
4.5	21813.57	60199.03	82012.60	14421.98	-29286.97
5.0	18903.25	56815.16	75718.41	13570.71	-34729.89
5.5	16392.36	53727.21	70119.57	12793.71	-39551.73
6.0	14224.58	50904.11	65128.69	12083.26	-43832.16
6.5	12351.71	48318.42	60670.13	11432.53	-47639.98
7.0	10732.53	45945.87	56678.40	10835.45	-51034.63
7.5	9331.71	43764.95	53096.67	10286.67	-54067.59
8.0	8119.00	41756.58	49875.58	9781.43	-56783.43
8.5	7068.43	39903.81	46972.24	9315.48	-59220.82
9.0	6157.73	38191.57	44349.30	8885.06	-61413.34
9.5	5367.74	36606.46	41974.20	8486.81	-63390.19
10.0	4682.04	35136.49	39818.53	8117.72	-65176.78
10.5	4086.46	33771.00	37857.46	7775.12	-66795.25

PAGE TYPE 3

ALTERNATIVES FOR THIS GAME
BATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGED, THINNED AT AGE 30.

NUMBER OF YEARS PER GAME 30

CRITICAL PRICES	12.00	15.00	99.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALLOWABLE CUT	5	8	12	0	0	0	0	0	0	0
MINIMUM CUTTING AGE	110.	110.	110.	0.	0.	0.	0.	0.	0.	0.

ACRES IN WORKING CIRCLE 885

MINIMUM VALUES FOR INCLUSION IN TOTALS
- AGE, FOR GROWING STOCK 40.
- M BD. FT., FOR GROWING STOCK 1.5
- CU. FT., FOR COMMERCIAL CUT 300.
- M BD. FT., FOR COMMERCIAL CUT 1.5
- M BD. FT., FOR SALVAGE 1.5
- CU. FT. IN SAW LOG CUT 100.

ACRES PLANTED ANNUALLY 1
PERCENT OF ACRES LOST ANNUALLY .040

PSEUDORANDOM NUMBER GENERATOR 21.0
2222.0

COSTS IN FIRST YEAR OF GAME
- PER ACRE (ANNUAL) .20
- PER 100 CU. FT. HARVESTED .05
- PER M BD. FT. 1.56
- THIN ONE ACRE 25.00
- PLANT ONE ACRE 30.00
- CLEANUP OF ONE ACRE 25.00

RATE OF INCREASE IN COSTS .01

RELATIVE VALUE OF INTERMEDIATE CUTS
- STUMPAGE PRICE, CU. FT. 1.00
- STUMPAGE PRICE, BD. FT. .85

PAGE TYPE 4

OISTRIBUTION OF OVERSTORY ACRES BY AGE
8ATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGEO, THINNEO AT AGE 30.
YEAR WITHIN GAME 0

	AGE(YEAR)										
AGE(OECAOE)	0	1	2	3	4	5	6	7	8	9	TOTAL
0	5	0	0	0	0	0	0	0	0	0	5
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	8	8	8	8	8	8	8	8	8	8	80
4	8	8	8	8	8	8	8	8	8	8	80
5	8	8	8	8	8	8	8	8	8	8	80
6	8	8	8	8	8	8	8	8	8	8	80
7	8	8	8	8	8	8	8	8	8	8	80
8	8	8	8	8	8	8	8	8	8	8	80
9	8	8	8	8	8	8	8	8	8	8	80
10	8	8	8	8	8	8	8	8	8	8	80
11	8	8	8	8	8	8	8	8	8	8	80
12	8	8	8	8	8	8	8	8	8	8	80
13	8	8	8	8	8	8	8	8	8	8	80
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 4

OISTRIBUTION OF UNOERSTORY ACRES BY AGE
BATCH SHELTERWOOO TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGEO, THINNEO AT AGE 30.
YEAR WITHIN GAME 0

	AGE(YEAR)										
AGE(OECAOE)	0	1	2	3	4	5	6	7	8	9	TOTAL
0	653	8	8	8	8	8	8	8	8	8	725
1	8	8	8	8	8	8	8	8	8	8	80
2	8	8	8	8	8	8	8	8	8	8	80
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 4

DISTRIBUTION OF OVERSTORY ACRES BY AGE
BATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGED, THINNED AT AGE 30.
YEAR WITHIN GAME 30

	AGE(YEAR)										
AGE(DECADE)	0	1	2	3	4	5	6	7	8	9	TOTAL
0	0	1	0	0	1	0	0	1	0	0	3
1	1	0	0	1	0	1	0	0	1	0	4
2	0	1	0	0	1	1	1	1	1	1	7
3	9	8	8	8	8	8	8	8	8	8	81
4	8	8	8	8	8	8	8	8	8	8	80
5	8	8	8	8	8	8	8	8	8	8	80
6	8	8	8	8	8	8	8	8	8	8	80
7	8	8	8	8	8	8	8	6	8	8	78
8	8	8	8	8	8	8	8	8	8	8	80
9	8	8	7	7	8	8	8	8	8	8	78
10	8	8	8	8	8	8	8	8	7	7	78
11	8	8	8	8	8	8	8	8	8	8	80
12	8	8	8	8	7	7	8	8	8	8	78
13	8	6	8	8	8	8	8	8	8	8	78
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 4

DISTRIBUTION OF UNDERSTORY ACRES BY AGE
BATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGED, THINNED AT AGE 30.
YEAR WITHIN GAME 30

	AGE(YEAR)										
AGE(DECADE)	0	1	2	3	4	5	6	7	8	9	TOTAL
0	657	8	9	8	11	12	12	11	12	8	748
1	7	12	8	3	8	7	5	5	4	5	64
2	8	7	5	5	8	8	8	8	8	8	73
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 5

STATUS OF FOREST AT ENO OF EACH YEAR
BATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGEO, THINNEO AT AGE 30.

YEAR	ALLOWABLE CUT (1)	CUTTING AGE (2)	ACTUAL CUT CU.FT. (3)	ACTUAL CUT MBF (4)	CUMUL CUT CU.FT. (5)	CUMUL CUT MBF (6)	GRSTK VOL CU.FT. (7)	GRSTK VOL MBF (8)	TOTAL VOL CU.FT. (9)	TOTAL VOL MBF (10)
0	0	0	0	0	0	0	146122	7210	146122	7210
1	8	110	12179	248	12179	248	146122	7210	158301	7458
2	8	110	12179	248	24358	496	146122	7210	170480	7706
3	8	110	12179	266	36537	762	146122	7192	182659	7954
4	8	110	12179	248	48716	1010	146122	7192	194838	8202
5	8	110	12179	248	60895	1258	146122	7191	207017	8449
6	8	110	12179	268	73074	1526	146122	7172	219196	8698
7	5	110	11262	212	84336	1738	146122	7207	230458	8945
8	5	110	11265	213	95601	1951	146122	7241	241723	9192
9	7	110	11881	252	107482	2203	146122	7237	253604	9440
10	8	110	12185	250	119667	2453	146122	7234	265789	9687
11	5	110	11268	214	130935	2667	146122	7268	277057	9935
12	4	110	10961	207	141896	2874	146122	7306	288018	10180
13	5	110	11276	215	153172	3089	146122	7336	299294	10425
14	5	110	11278	215	164450	3304	146122	7365	310572	10669
15	7	110	11901	261	176351	3565	146122	7350	322473	10915
16	8	110	12212	254	188563	3819	146122	7343	334685	11162
17	4	110	10976	209	199539	4028	146122	7377	345661	11405
18	8	110	12222	255	211761	4283	146122	7369	357883	11652
19	12	110	13456	305	225217	4588	146122	7315	371339	11903
20	7	110	11901	247	237118	4835	146122	7313	383240	12148
21	8	110	12212	254	249330	5089	146122	7305	395452	12394
22	12	110	13446	304	262776	5393	146122	7251	408898	12644
23	11	110	11784	300	274560	5693	146122	7200	420682	12893
24	12	110	13425	301	287985	5994	146122	7148	434107	13142
25	12	110	13412	299	301397	6293	146122	7094	447519	13387
26	11	110	13101	300	314498	6593	146122	7038	460620	13631
27	8	110	11755	220	326253	6813	146122	7064	472375	13877
28	9	110	12061	232	338314	7045	146122	7077	484436	14122
29	8	110	12037	259	350351	7304	146122	7063	496473	14367
30	8	110	12179	248	362530	7552	146122	7059	508652	14611

PAGE TYPE 5

STATUS OF FOREST AT ENO OF EACH YEAR
BATCH SHELTERWOOO TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGEO, THINNEO AT AGE 30.

YEAR	NON STK (11)	AGE CLASSES, OVERSTORY 0-9 (12)	10-19 (13)	20-29 (14)	30-39 (15)	40-49 (16)	50-59 (17)	60-69 (18)	70-79 (19)	80-89 (20)	90-99 (21)	100-109 (22)	110-119 (23)	120-129 (24)	130-139 (25)	140-179 (26)
0	5	5	0	0	80	80	80	80	80	80	80	80	80	80	80	0
1	4	5	0	0	80	80	80	80	80	80	80	80	80	80	80	0
2	3	5	0	0	80	80	80	80	80	80	80	80	80	80	80	0
3	3	6	0	0	80	80	80	80	80	80	80	79	80	80	80	0
4	2	6	0	0	80	80	80	80	80	80	80	79	80	80	80	0
5	1	6	0	0	80	80	80	80	80	80	80	79	80	80	80	0
6	1	7	0	0	80	80	80	80	80	80	80	78	80	80	80	0
7	0	7	0	0	80	80	80	80	80	80	80	78	80	80	80	0
8	0	7	0	0	80	80	80	80	80	80	80	78	80	80	80	0
9	1	8	0	0	80	80	80	80	80	79	80	80	78	80	80	0
10	0	7	1	0	80	80	80	80	80	79	80	80	78	80	80	0
11	0	6	2	0	80	80	80	80	80	79	80	80	78	80	80	0
12	1	6	3	0	80	80	80	80	79	80	79	80	78	80	80	0
13	0	5	4	0	80	80	80	80	79	80	79	80	78	80	80	0
14	0	4	5	0	80	80	80	80	79	80	79	80	78	80	80	0
15	1	4	6	0	80	80	80	80	79	80	79	79	78	80	80	0
16	0	3	7	0	80	80	80	80	79	80	79	80	77	80	80	0
17	1	4	7	0	80	80	80	79	79	80	79	80	77	80	80	0
18	0	4	7	0	80	80	80	79	80	79	79	80	77	80	80	0
19	0	3	8	0	80	80	80	79	80	79	79	80	79	78	80	0
20	1	4	7	1	80	80	80	78	80	79	79	80	79	78	80	0
21	0	4	6	2	80	80	80	78	80	79	79	80	79	78	80	0
22	0	3	6	3	80	80	80	78	80	79	80	79	79	78	80	0
23	1	4	5	4	80	80	80	80	78	79	80	79	78	78	80	0
24	0	4	4	5	80	80	80	80	78	79	80	79	78	78	80	0
25	0	3	4	6	80	80	80	80	78	79	80	79	79	77	80	0
26	1	4	3	7	80	80	80	80	78	78	80	79	80	76	80	0
27	0	3	4	7	80	80	80	80	78	79	79	79	80	76	80	0
28	0	3	4	7	80	80	80	80	78	80	78	79	80	76	80	0
29	1	4	3	8	80	80	80	80	78	80	78	78	80	78	78	0
30	0	3	4	7	81	80	80	80	78	80	78	78	80	78	78	0

PAGE TYPE 5

STATUS OF FOREST AT END OF EACH YEAR
8ATCH SHELTERWOOO TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGEO, THINNEO AT AGE 30.

YEAR	NON STK (11)	AGE CLASSES, UNOERSTORY 0-9 (12)	10-19 (13)	20-29 (14)	30-39 (15)	40-49 (16)	50-59 (17)	60-69 (18)	70-79 (19)	80-89 (20)	90-99 (21)	100-109 (22)	110-119 (23)	120-129 (24)	130-139 (25)	140-179 (26)
0	5	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
1	4	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
2	3	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
3	3	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
4	2	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
5	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
6	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
7	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
8	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
9	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
10	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
11	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
12	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
13	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
14	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
15	1	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
16	0	725	80	80	0	0	0	0	0	0	0	0	0	0	0	0
17	1	728	77	80	0	0	0	0	0	0	0	0	0	0	0	0
18	0	731	74	80	0	0	0	0	0	0	0	0	0	0	0	0
19	0	732	73	80	0	0	0	0	0	0	0	0	0	0	0	0
20	1	732	73	80	0	0	0	0	0	0	0	0	0	0	0	0
21	0	735	70	80	0	0	0	0	0	0	0	0	0	0	0	0
22	0	739	66	80	0	0	0	0	0	0	0	0	0	0	0	0
23	1	742	63	80	0	0	0	0	0	0	0	0	0	0	0	0
24	0	745	60	80	0	0	0	0	0	0	0	0	0	0	0	0
25	0	746	59	80	0	0	0	0	0	0	0	0	0	0	0	0
26	1	746	59	80	0	0	0	0	0	0	0	0	0	0	0	0
27	0	751	57	77	0	0	0	0	0	0	0	0	0	0	0	0
28	0	751	60	74	0	0	0	0	0	0	0	0	0	0	0	0
29	1	747	65	73	0	0	0	0	0	0	0	0	0	0	0	0
30	0	748	64	73	0	0	0	0	0	0	0	0	0	0	0	0

PAGE TYPE 5

STATUS OF FOREST AT ENO OF EACH YEAR
8ATCH SHELTERWOOO TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGEO, THINNEO AT AGE 30.

YEAR	STUMPAGE PRICE 100 CU.FT. (27)	M8F (28)	STUMPAGE INCOME ANNUAL (29)	CUMULATED (30)	AREA COSTS ANNUAL (31)	CUMULATEO (32)	VOLUME COSTS ANNUAL (33)	CUMULATEO (34)
0	2.50	14.50	0.	0.	0.	0.	0.	0.
1	2.50	15.20	4025.	4025.	407.	407.	394.	394.
2	2.50	17.80	4661.	8686.	411.	818.	398.	791.
3	2.50	16.80	4671.	13356.	415.	1233.	430.	1221.
4	2.50	13.40	3584.	16940.	419.	1653.	406.	1627.
5	2.50	14.10	3755.	20696.	424.	2076.	410.	2037.
6	2.50	17.40	4846.	25541.	428.	2504.	445.	2482.
7	2.50	11.80	2744.	28286.	432.	2936.	358.	2840.
8	2.50	11.10	2608.	30893.	404.	3340.	363.	3202.
9	2.50	12.20	3303.	34197.	408.	3748.	433.	3635.
10	2.50	12.90	3480.	37677.	445.	4193.	433.	4068.
11	2.50	10.10	2404.	40080.	416.	4610.	375.	4443.
12	2.50	8.30	1956.	42037.	421.	5031.	367.	4810.
13	2.50	9.00	2183.	44220.	459.	5489.	384.	5194.
14	2.50	10.90	2587.	46807.	429.	5918.	389.	5582.
15	2.50	13.90	3830.	50637.	433.	6352.	475.	6057.
16	2.50	13.10	3580.	54217.	473.	6824.	467.	6524.
17	2.50	11.90	2705.	56923.	442.	7266.	388.	6912.
18	2.50	12.70	3495.	60417.	482.	7748.	478.	7390.
19	2.50	15.70	5064.	65481.	451.	8199.	577.	7967.
20	2.50	13.60	3598.	69079.	455.	8655.	473.	8440.
21	2.50	12.10	3330.	72409.	497.	9151.	490.	8931.
22	2.50	15.20	4896.	77305.	465.	9616.	592.	9523.
23	2.50	16.10	5041.	82346.	469.	10085.	590.	10113.
24	2.50	16.70	5299.	87645.	512.	10597.	599.	10712.
25	2.50	19.60	6117.	93762.	479.	11075.	600.	11312.
26	2.50	18.50	5775.	99538.	483.	11559.	609.	11921.
27	2.50	14.70	3474.	103012.	527.	12086.	451.	12373.
28	2.50	15.50	3841.	106853.	493.	12579.	481.	12853.
29	2.50	17.10	4622.	111474.	498.	13077.	543.	13396.
30	2.50	13.00	3486.	114961.	577.	13654.	525.	13921.

PAGE TYPE 5

STATUS OF FOREST AT END OF EACH YEAR
BATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGED, THINNED AT AGE 30.

YEAR	TOTAL COST ANNUAL (35)	TOTAL COST CUMULATED (36)	NET INCOME ANNUAL (37)	NET INCOME CUMULATED (38)	CURRENT VALUE GROWING STOCK (39)	TOTAL NET WORTH (40)
0	0.	0.	0.	0.	96878.	96878.
1	801.	801.	3224.	3224.	101925.	105149.
2	809.	1609.	3852.	7076.	120557.	127634.
3	845.	2455.	3825.	10902.	112962.	123864.
4	825.	3280.	2759.	13661.	88388.	102049.
5	833.	4113.	2922.	16583.	93301.	109884.
6	873.	4986.	3973.	20556.	116607.	137163.
7	790.	5776.	1955.	22510.	76683.	99193.
8	767.	6542.	1841.	24351.	71842.	96193.
9	841.	7383.	2463.	26814.	79636.	106450.
10	878.	8261.	2602.	29415.	84554.	113969.
11	791.	9053.	1613.	31028.	64456.	95484.
12	787.	9840.	1169.	32197.	51493.	83690.
13	843.	10683.	1340.	33537.	56696.	90233.
14	818.	11500.	1770.	35306.	70769.	106076.
15	908.	12408.	2922.	38228.	92552.	130780.
16	939.	13348.	2641.	40870.	86459.	127328.
17	830.	14178.	1875.	42744.	77863.	120607.
18	960.	15138.	2535.	45279.	83539.	128818.
19	1028.	16166.	4036.	49315.	104755.	154070.
20	929.	17095.	2669.	51984.	89233.	141217.
21	987.	18082.	2343.	54327.	78047.	132374.
22	1057.	19139.	3839.	58167.	99832.	157998.
23	1059.	20198.	3981.	62148.	105508.	167656.
24	1110.	21308.	4189.	66337.	108907.	175244.
25	1079.	22387.	5038.	71375.	128548.	199924.
26	1093.	23480.	4682.	76057.	119690.	195747.
27	979.	24459.	2496.	78553.	93120.	171673.
28	974.	25432.	2867.	81420.	98806.	180226.
29	1041.	26473.	3581.	85001.	109771.	194772.
30	1102.	27575.	2384.	87386.	80629.	168015.

PAGE TYPE 6

PRESENT WORTH AND RATE EARNED
BATCH SHELTERWOOD TEST
TEST 1
GAME VARY CUT WITH PRICE
MANAGED, THINNED AT AGE 30.
YEARS IN PERIOD 30

VALUE OF INITIAL GROWING STOCK--$ 96877.59

VALUES DISCOUNTED TO PRESENT (DOLLARS)

COMPOUND RATE (PERCENT)	FUTURE GROWING STOCK	ALL INCOMES	STOCK PLUS INCOMES	ALL COSTS	NET PRESENT WORTH
1.0	59820.71	98225.77	158046.48	23515.58	37653.31
1.5	51583.58	91122.91	142706.49	21789.26	24039.64
2.0	44513.08	84733.69	129246.77	20234.40	12134.78
2.5	38439.42	78976.23	117415.64	18831.48	1706.58
3.0	33218.19	73778.79	106996.99	17563.40	-7444.00
3.5	28726.47	69078.51	97804.98	16415.18	-15487.79
4.0	24859.51	64820.17	89679.69	15373.64	-22571.54
4.5	21528.02	60955.27	82483.29	14427.20	-28821.50
5.0	18655.80	57441.11	76096.91	13565.67	-34346.35
5.5	16177.78	54240.08	70417.86	12780.03	-39239.76
6.0	14038.37	51318.98	65357.36	12062.37	-43582.60
6.5	12190.02	48648.53	60838.55	11405.64	-47444.68
7.0	10592.04	46202.80	56794.84	10803.65	-50886.40
7.5	9209.56	43958.86	53168.42	10250.88	-53960.05
8.0	8012.72	41896.36	49909.08	9742.44	-56710.95
8.5	6975.91	39997.24	46973.15	9274.00	-59178.43
9.0	6077.12	38245.48	44322.60	8841.68	-61396.66
9.5	5297.48	36626.80	41924.28	8442.04	-63395.35
10.0	4620.75	35128.48	39749.23	8072.00	-65200.36
10.5	4032.96	33739.18	37772.15	7728.84	-66834.28

PAGE TYPE 7

COMPARISON OF ALTERNATIVES
BATCH SHELTERWOOD TEST
TEST 1
MANAGED, THINNED AT AGE 30.
COLUMN 10

YEAR	GAME 1	GAME 2	GAME 3	GAME 4	GAME 5	GAME 6	GAME 7	GAME 8	GAME 9	GAME 10
1	7458.	7458.	0.	0.	0.	0.	0.	0.	0.	0.
2	7706.	7706.	0.	0.	0.	0.	0.	0.	0.	0.
3	7954.	7954.	0.	0.	0.	0.	0.	0.	0.	0.
4	8203.	8202.	0.	0.	0.	0.	0.	0.	0.	0.
5	8451.	8449.	0.	0.	0.	0.	0.	0.	0.	0.
6	8699.	8698.	0.	0.	0.	0.	0.	0.	0.	0.
7	8947.	8945.	0.	0.	0.	0.	0.	0.	0.	0.
8	9194.	9192.	0.	0.	0.	0.	0.	0.	0.	0.
9	9442.	9440.	0.	0.	0.	0.	0.	0.	0.	0.
10	9689.	9687.	0.	0.	0.	0.	0.	0.	0.	0.
10	9689.	9687.	0.	0.	0.	0.	0.	0.	0.	0.
20	12157.	12148.	0.	0.	0.	0.	0.	0.	0.	0.
30	14615.	14611.	0.	0.	0.	0.	0.	0.	0.	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
50	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
60	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
70	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
90	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PAGE TYPE 7

COMPARISON OF ALTERNATIVES
BATCH SHELTERWOOD TEST
TEST 1
MANAGED, THINNED AT AGE 30.
COLUMN 40

YEAR	GAME 1	GAME 2	GAME 3	GAME 4	GAME 5	GAME 6	GAME 7	GAME 8	GAME 9	GAME 10
1	105149.	105149.	0.	0.	0.	0.	0.	0.	0.	0.
2	127634.	127634.	0.	0.	0.	0.	0.	0.	0.	0.
3	123856.	123864.	0.	0.	0.	0.	0.	0.	0.	0.
4	102001.	102049.	0.	0.	0.	0.	0.	0.	0.	0.
5	109843.	109884.	0.	0.	0.	0.	0.	0.	0.	0.
6	137152.	137163.	0.	0.	0.	0.	0.	0.	0.	0.
7	99075.	99193.	0.	0.	0.	0.	0.	0.	0.	0.
8	96107.	96193.	0.	0.	0.	0.	0.	0.	0.	0.
9	106310.	106450.	0.	0.	0.	0.	0.	0.	0.	0.
10	113796.	113969.	0.	0.	0.	0.	0.	0.	0.	0.
10	113796.	113969.	0.	0.	0.	0.	0.	0.	0.	0.
20	140494.	141217.	0.	0.	0.	0.	0.	0.	0.	0.
30	166068.	168015.	0.	0.	0.	0.	0.	0.	0.	0.
40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
50	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
60	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
70	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
90	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Agriculture—CSU, Ft. Collins

Myers, Clifford A.
1973. Simulating changes in even-aged timber stands. USDA For. Serv. Res. Pap. RM-109, **47** p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 80521.

Growth and volume relationships are assembled in a computer program, written in FORTRAN IV, that simulates timber management by shelterwood, seed tree, or clearcutting systems. Tree growth, intermediate and regeneration cuts, planting, and catastrophic losses are among the changes computed. Annual and periodic costs and returns, analysis of rate earned, and other statements of volume and value are printed. Supersedes USDA For. Serv. Res. Pap. RM-42.

Oxford: 524.37:U681.3. **Keywords:** Stand yield tables, timber management, forest management, simulation, *Pinus ponderosa, Pinus contorta.*

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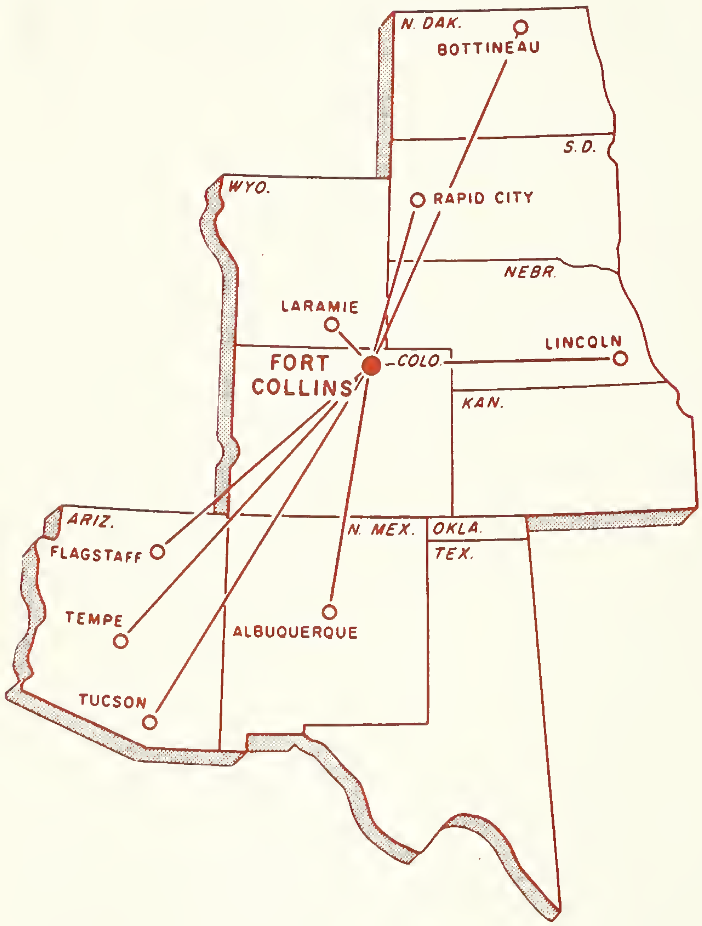
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